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Edited at the
Massachusetts Institute
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TechnologyReview

RAnam dissecui, atque præparavi ut in *Fig.* 2. *Tab.* I., eamque in tabula, omnia mihi alia proponens, in qua erat machina electrica *Fig.* 1. *Tab.* I., collocavi ab ejus conductore penitus sejunctam, atque haud brevi intervallo dissitam; dum scalpelli cuspidem unus ex iis, qui mihi operam dabant, cruralibus hujus ranæ internis nervis DD casu vel leviter admoveret, continuo omnes artuum musculi ita contrahi visi sunt, ut in vehementiores incidisse tonicas convulsiones viderentur. Eorum vero alter, qui nobis electricitatem tentantibus præsto erat, animadvertere sibi visus est, rem contingere dum ex conductore machinæ scintilla extorqueretur. Rei novitatem ille admiratus de eadem statim me alia omnino molientem, ac mecum ipso cogitantem admonuit. Hic ego incredibili sum studio, & cupiditate incensus idem experiundi, & quod occultum in re esset in lucem proferendi. Admovi propterea & ipse scalpelli cuspidem nervo, quo tempore unus aliquis ex iis, correptum, eodem ipso temporis momento inducebantur, quo perinde ac si tetano præparatum animal esset scintillæ extorquerentur.

"We now believe that low-level electrical potentials... have the capability of bringing about very major biological effects..."

At metuens, ne ii ipsi motus a cuspidis potius contactu, qui pro stimulo forte esset, quam a scintilla orirentur, eosdem nervos iterum eadem ratione in aliis ranis cuspide tentavi, & quidem gravius, quin ulla tamen scintilla tunc temporis ab aliquo eliceretur, at nulli omnino visi sunt motus. Hinc mecum ipse putavi, forte ad phænomenon inducendum & contactum ali-

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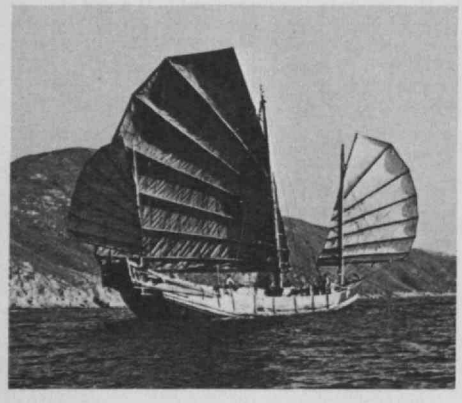

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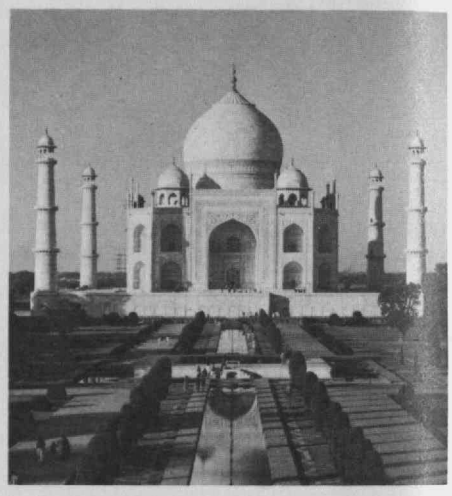

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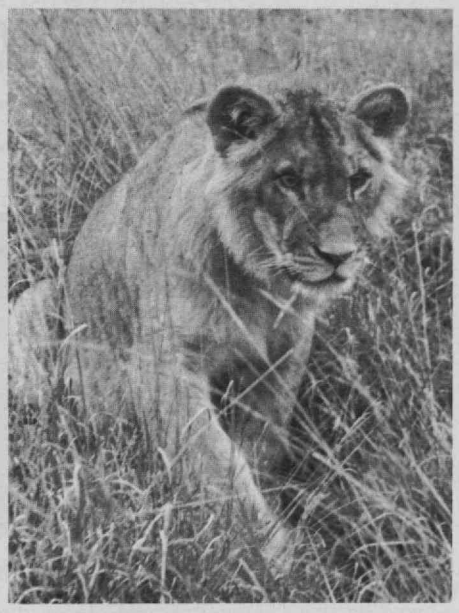

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Preliminary Announcement

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Preliminary Announcement

An unusual blend of countries in the Mediterranean area, visiting TUNISIA, the Dalmatian Coast of YUGOSLAVIA, and MALTA. Starting in TUNIS, the tour explores the coast and interior of Tunisia: the ruins of the famed ancient city of CARTHAGE as well as the ruins of extensive Roman cities such as DOUGGA, SBEITLA, THUBURBO MAJUS and the magnificent amphitheater of EL DJEM, historic Arab towns and cities such as NABEUL, HAMMAMET, SOUSSE and KAIROUAN, the caves of the troglodytes at MATMATA, beautiful beaches at ZARZIS and on the "Isle of the Lotus Eaters" at DJERBA, and desert oases at GABES, TOZEUR and NEFTA. The beautiful Dalmatian Coast of Yugoslavia is represented by SPLIT, with its famous Palace of Diocletian, and the medieval walled city of DUBROVNIK, followed by the island of MALTA, with its treasure house of 17th and 18th century churches and palaces, where the Knights of St. John, driven from the Holy Land and from Rhodes, withstood the epic seige of the Turks and helped to decide the fate of Europe. It is anticipated that the tour will be of three weeks' duration and that it will be inaugurated in the fall of 1973. Further details, including the tour cost, will be announced as soon as possible.

* * *

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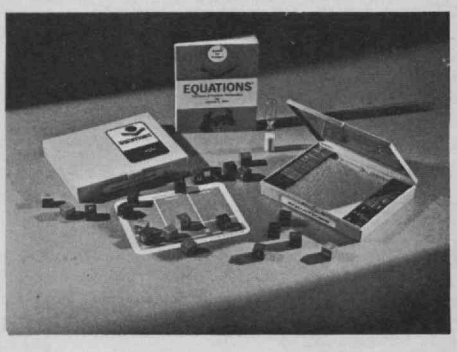

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Technology Review

Edited at the
Massachusetts Institute of Technology
Volume 75, Number 2
December, 1972

Articles

Departments

First Line

Fred Wheeler's name makes its last appearance (at least for the present—one may always hope for the future) in our masthead this month. He has determined to return to England, whence he came to the *Review* as Managing Editor in January, 1969, from *New Scientist.*

No superficial tribute can acknowledge Fred Wheeler's contributions to the *Review.* For he is at once a voracious reader, a sharp critic, a keen intellect, and a fine humorist, and he has given of all these talents in abundance to this magazine. The place he has made for himself here—and through the *Review* with readers throughout the U.S. and overseas—will not be easily filled. He leaves us with generous good wishes, which we reciprocate.

During Mr. Wheeler's tenure here, *Technology Review* has gained most of its present 12,500 subscribers who are otherwise outside the M.I.T. community; these include addresses in every state and in 47 foreign countries. It is fair to say, in fact, that we have achieved a kind of majority: the *Review* is indexed in the major services which deal with science, technology, and science policy; it is increasingly quoted and reprinted.

Mr. Wheeler's successor at the *Review* will be Ralph Segman, who has since 1967 been Public Affairs Officer at the Environmental Research Laboratories of the National Oceanic and Atmospheric Administration in Boulder, Colo. Trained in chemistry at Syracuse University (A.B. 1951) and in journalism at the Columbia School of Journalism (M.S., 1954), Mr. Segman is well known as a science writer; he has been associated with the Interagency Committee on Oceanog-

F. Wheeler

R. Segman

raphy, *Science News* (of which he was News Editor in 1958), the U.S. Information Agency, Eli Lilly and Co., and the Associated Press.

Mr. Segman views the *Review* as an exciting project—as we do—because of its concern for "the effects of science and technology on society" and its focus on technology assessment, which he believes "can become a historically significant innovation." Obviously, we welcome him.—*J.M.*

Letters

M.I.T. and Its Graduates' Success

I think the authors of "Where Are They Now and What Are They Doing?" (*June, 1972, pp. 32-40*) have competely missed the most important point. Their conclusion is that, referring to engineers, "future research might well focus on how M.I.T. can help resolve these frustrations by providing either opportunities for technical up-dating or training for career transitions."

The most important point is that *half the alumni feel that M.I.T. did not contribute much to their success.* When one thinks of the time and money and tremendous effort invested by all the students, and that half the students consider their investments to be bad ones, then M.I.T. has been notably unsuccessful. What a waste! The only positive suggestion I can think of at this point is that there should be a massive and continuing counseling program.

Ronald Silver (M.I.T.'51)
Pleasanton, Calif.

Engineering the Wrong Direction?

I persist in feeling like a confused descendent of that child who looked at "The Emperor's New Clothes" and spoke out a truth, that there was nothing there. To me it seems perfectly evident that our best technical-scientific minds have gone off in exactly the wrong direction; that in this day, the whole interest of technology (and of M.I.T.) should be directed toward developing better and economically feasible means and methods for recycling materials that are suited to the process, creating energy and fertilizer from refuse, and developing clever new versions of machines that multiply man's capabilities using man's own energy as the power source. Perfect examples: the bicycle and the treadle-operated sewing machine.

Dorothy Kussmaul
Philadelphia, Pa.

Insect Controls: Yes, Please!

Mr. Boehm's wide-angled and unbiased treatise, "After D.D.T., What" (*July/August, 1972, pp. 26-31*) boils down (in my words) to: "The consumer may have to tolerate somewhat poorer quality produce at the supermarket counter while halfway interim control measures are in effect, until scientists come up with more ideal solutions to the many-pronged problem."

Devotees of the growing method known as "organic gardening" make extravagant claims of growing well-nigh perfect produce entirely without the use of insecticides or commercial fertilizers. As a casual sampler of "organically grown" produce, my judgment (from the epicure's standpoint) greatly favors the supermarket offering. Furthermore, I soberly question the availability of sufficient quantities of "natural" fertilizers (both animal and vegetable) to care for the needs of a vitamin- and mineral-hungry populace such as ours.

Charles A. Abels
Nashua, N. H.

Feedback: Power and Limits

A danger in the superficial use of analogy, such as Jack C. Page's in "Engineering Social Systems" (*July/August, pp. 43-47*), appears to be that the constructions are subject to the builder's prejudice. I would have thought, for example, that bussing would be an example of inverse feedback (the poor children get the schools built by the rich and vice versa), while an attempt to equalize education by federal regulation would correspond to the Edison brute-force example. Unless the analogy is much more carefully employed, almost any conclusion is possible.

That the author does not really believe in the similarity of systems, but simply uses analogy to advance his own ideas, is illustrated by his willingness to drop the analogy as soon as it does not fit his purpose. He writes, "The organization has two advantages over the steam boiler." Then he proceeds to endorse a system of rewards and punishments which is the ultimate in positive feedback, tending to make organizations more homogeneous. Note that I do not say above or below average—but only homogeneous. I guess I do not believe that people have a property that can be ranked overall—only qualities in situations. A gold-medal swimmer is not a better athlete or a better person than a gold-medal boxer—only a better swimmer.

I was almost persuaded that a random "blowdown" scheme where people are relocated between organizations could be beneficial. Certainly this is the approach that many large organizations take toward personnel in their suborganizations. I wish the article had pursued the analogies initially implied. Some surprising and useful ideas could result.

Gerry B. Andeen
Menlo Park, Calif.

Mr. Page's article is provocative but should not be taken too literally.

In particular, the idea that one could get a better balance of transportation by using taxes on gasoline, tires, cars, etc., to improve the railroads, then allocating the tax revenues generated by railroads to subsidize the airlines, and finally in turn taxing the airlines to build new roads for automobiles is intriguing but involves some fallacies.

If this principle had been in effect for the last 125 years, the creation of the transcontinental railroads would have depended upon taxes levied on horse-drawn stage coaches and covered wagons rather than upon the land grants awarded by Congress, the development of automobile transportation would have been controlled by the taxes levied on railroad operations and hence indirectly by the taxes that could be raised from stage coaches and covered wagons, and the revenues that could be raised from

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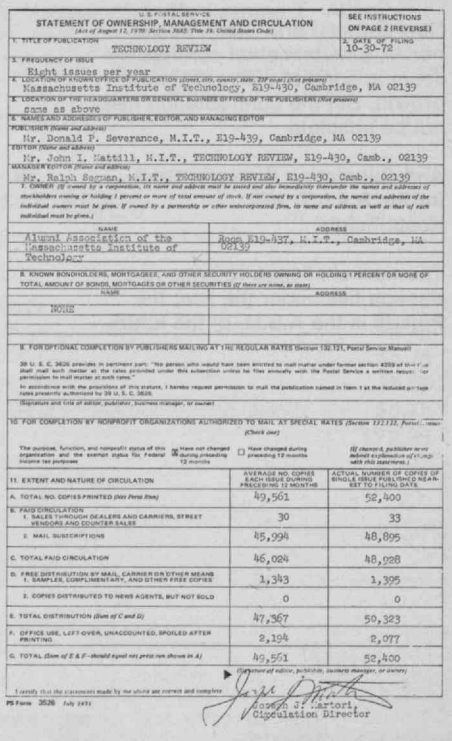

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C. TOTAL PAID CIRCULATION	46,024	48,928
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2. COPIES DISTRIBUTED TO NEWS AGENTS, BUT NOT SOLD	0	0
E. TOTAL DISTRIBUTION (Sum of C and D)	47,367	50,323
F. OFFICE USE, LEFT-OVER, UNACCOUNTED, SPOILED AFTER PRINTING	2,194	2,077
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I certify that the statements made by me above are correct and complete.

Joseph J. Martori, Circulation Director

PS Form 3526 July 1971

airline transportation would be used to support covered wagon systems.

If everything new is thus tied to everything old and/or obsolete through such use of "negative feedback," the world would be in a sad state. Although Mr. Page tries to bolster his presentation by referring to the "balance of nature," it is to be remembered that the dinosaur is extinct, and we should not use "social engineering" concepts to prevent obsolete technology from likewise becoming extinct.

Frederick E. Terman
Stanford, Calif.

Mr. Page responds:

Businesses are, as Mr. Andeen points out, positive feedback systems wherein engineering firms tend to develop good engineers, sales organizations good salesmen, etc. I don't think this is bad, particularly if those responsible for their management recognize the strengths and weaknesses of such systems. But carrying forward with Mr. Andeen's analogy, the purpose of a competitive swimming team is to attract, cultivate and develop good swimmers. Applying the "blow-down" concept would require annual purging of the bottom 10 per cent of the team. Concurrently, the team would experience a greater influx of recruits because of those "blown down" from other sports and would have a larger universe from which to develop its squad. In the long haul I believe all would benefit.

As Dr. Terman points out, inverse feedback stabilizes the system around existing technology when put into effect. That does not, however, preclude the development of new technologies possibly with positive feedback outside the system; these can then be tied into the system as they prove themselves and become mature. It also does not preclude dropping obsolete technologies—as would now be done with stage coaches and covered wagons. Thus the total system remains steady on a course; but it requires periodic but infrequent attention to change that course as technologies develop and circumstances warrant. Whether this is a good trade-off compared to the existing system is for the reader to decide.

Dismay Justified

One of our executives called to my attention your article (May, p. 62) on steam generating systems that use refuse as part of the firing material.

You can appreciate his dismay upon finding our company identified as "Construction Engineering, Inc." Our legal name is Combustion Engineering, Inc. We are one of the two major manufacturers of steam generating systems in the United States. Our sales last year totaled over $1 billion and we employed over 32,000 people worldwide.

Robert A. Amen
Combustion Engineering, Inc.
Stamford, Conn.

Illuminating Illuminaton

In arguing that much electricity is wasted in the planning and usage of buildings, Richard Stein (*see "Trend of Affairs" for May, p. 62*) devotes considerable attention to illumination. Those who criticize current illumination levels as he does often do so in terms of reading printed material, but this is actually not a difficult visual task. Reading a spirit-duplicated work-sheet in a schoolroom or a fifth carbon copy in an office can be much more demanding. Critics also frequently overlook the well-established fact that old eyes require several times as much light as young eyes for equal ease in seeing.

Use of the word "fatigue" is another booby trap. We all know what we mean when we say, "My eyes are tired," but there is no objective way of measuring fatigue—or even of defining it.

Even if reading rate were a valid measure, it would be only one part of a complex story. The visual environment seems to affect motivations and productivity through various physiological and psychological reactions. Back in 1935 some research of my own showed fifth-grade children learning faster under illumination of 20 footcandles than under 4 to 6 fc.

One more point, which may be a quibble, but which shows that Mr. Stein is mixed up on his facts: He says, ". . . the eye moves easily between bright snow (1,500 fc.) and tree shadows (20 fc.)." Apparently he confuses illumination, measured in footcandles, with luminance (sometimes called brightness), measured in footlamberts. Illumination from the noon-day sun in winter varies from around 3,000 to 6,000 fc. on a horizontal plane, depending upon the month. Values on a vertical plane run from about 7,000 to 8,000 fc. If we assume 90 per cent reflectance for the snow, the luminance would fall between 2700 and 7200 fL. It's anybody's guess what the tree shadows might be, but the important factor, visually, would be the footlamberts of luminance, not the footcandles of illumination.

Willard Allphin
Danvers, Mass.

Leading Us Toward Anarchy?

The letter from Moses Cammer in July/August (*"Wanted: An Ellsberg for the A.E.C.," p. 4*) seems to come from a Moses who is trying to lead us in the wrong direction—toward anarchy.

Dr. Ellsberg and others who take things into their own hands, violating our important laws because something displeases them, are anarchists; and we should be well aware of it. Candor in government, or in industrial organizations, or in institutions, is often woefully lacking; but the answer is to work for change within the system, difficult as that may be. Ellsbergs lead only to anarchy and chaos, not a better world.

George D. Ray
Oak Brook, Ill.

Polluters: Catch Big and Little Alike

Victor Cohn (*see "Cutting the Legs Off Section 102," May, pp. 7-8*) is rightly worried about emasculation of the National Environmental Policy Act.

I believe that one of the most significant court decisions concerned with this Act was that which instructed the Army Corps of Engineers to issue an

environmental impact statement on each license to discharge wastes into navigable waterways. These cover many polluters—21,000 permits are outstanding—and it is probable that the sum total of their pollution far exceeds the pollution of the few large polluters licensed, for example, by the Atomic Energy Commission. It is easy to catch the big guy; only by insistence on correct procedure can we catch the many small ones. Conservation groups are unlikely to attack the small ones; there is not enough publicity.

Mr. Cohn may be concerned over the effect of slowing or stopping existing projects. This interim problem, as federal agencies adjust to the requirements of N.E.P.A., can be serious. Most of the key cases have this characteristic. The A.E.C. did not deny the necessity of producing an environmental impact statement in the Quad Cities case, and their license was an interim one, for low power only. What is the distinction between stopping an operating power station which is known to pollute, and preventing operation of a new, ready power station which may not pollute?

Mr. Cohn is right; N.E.P.A. is in danger. But it must not be an act to prevent the few large-scale polluters only, and to permit many thousands of small ones to continue.

Richard Wilson
Cambridge, Mass.

A Primitive Culture?

Concerning your item entitled "Speedy 'Primitives'" (*March/April, 1972, p. 64*), perhaps the "rugged individualists" are bored with primitive music and "art?" but prove receptive to the dawn of reason and those aspects of culture which require more disciplined personal development than relatively unrestrained free expression.

Dr. Gajdusek's view of "culture" as you report it seems primitively narrow.

Mark Rollinson
Washington, D.C.

Research on the Self-Evident?

You quote two researchers ("*A Village Model,*" Technology Review *for June, p. 64*) as saying, "Birth rates appeared to be governed by the choices people made . . .". I have heard the expression, "emphasizing the obvious." The findings of these researchers could be described as discovering what is self-evident.

Gilbert Caro-Delvaille
Riverside, Calif.

Engineering and Public Affairs

Michael Chiusano writes on page 65 of *Technology Review* for June ("Societal Engineering") that "no school now offers a degree in this new kind of engineering." But Carnegie-Mellon University now offers (and has had for a year or so) a degree in Engineering and Public Affairs dealing with areas such as government, urban development, and man-machine systems. This trains one to work at the interface of engineering and society. In addition, one can couple this degree with one in any of the standard engineering disciplines in a "double major" program.

William S. Clark, Jr.
Columbus, Ohio

Soviet + U.S.: 2+2 > 4

Science Review:
Robert C. Cowen

At Star City, near Moscow, Russian Cosmonauts are learning "American."

At Batavia, Ill., Soviet physicists have helped inaugurate America's new high-powered accelerator.

These and many other Soviet scientists and engineers now have a vision of the future which includes a previously unknown togetherness with American colleagues. President Nixon's visit to Moscow and the science agreements flowing from it hold out this prospect, and the seriousness with which the Russians take it was obvious everywhere to the five American science writers—including this author—who toured Russian laboratories for three weeks early this fall.

U.S. scientists would feel at home in most Russian laboratories—except, of course, for the language barrier and the absence of certain American equipment. The "feel" is familiar. The universal mode of scientific thought and even the overly familiar specialists' jokes moderated the stiff formality of our group interviews conducted through interpreters. Clearly we were dealing with the same culture which is familiar to all scientists everywhere. It is a solid foundation upon which a new, more intimate cooperation between American and Russian scientists may be built.

Can the long-standing barriers of mutual suspicion between the two nations indeed be breached? For example, would our status as guests mean that the five science writers in Russia this fall must soft-pedal "sensitive" questions—about Soviet secrecy, for example, or political repressions against scientists? "No," our Soviet journalist-hosts said, "You must ask the sensitive questions. This will be expected."

True, many replies were evasive or noncommital. But the constant refrain of officials and scientists alike was that, given mutual good will and much hard work, the difficulties can be overcome and a new level of fruitful cooperation attained.

The U.S.-Soviet agreements cover six very general fields—energy, computers in management, agriculture, microbiological production, water resources, and chemical catalysts. Academician Mikhail D. Miliontschikov explained to us that six expert groups will now search these fields for specific opportunities for cooperative work. But the main idea, he insisted, is simply to provide broad scope for Americans and Soviets to learn to work together.

It is not a one-sided problem; Americans, he said, should realize that they bear as much responsibility for removing the old distrusts as do the Soviets. He is particularly concerned at the American tendency to hold back certain elements of technology believed to have military implications—especially advanced computers. He cannot imagine "fruitful cooperation" in any science without openness on computers. "If you have no open door on computers," he observed, "you have no open door for anything else."

"A Business-Like Atmosphere"

Soviet-American scientific cooperation is perhaps farthest advanced in space, and the prospect for joint exploration of the cosmos is very promising. Each country seems to have concluded that competition is a fruitless, graceless way to open humanity's newest frontier.

Academician Boris Petrov, who oversees much of Russia's space research, told us that he—and he hopes the Americans, as well—is "quite satisfied" with cooperative efforts to date. They go on in "a business-like atmosphere of mutual understanding," he said, which "shows that such cooperation in creative jobs can exist and is very useful." The joint Russian-American space flight scheduled for 1975 has caught public imagination to best symbolize the new cooperation. It aims to demonstrate rendezvous and docking of Soviet and American space craft and should lead to a general space rescue system.

But the Russians envision broader opportunities; Major General Vladimir Shatalov, Russia's chief cosmonaut, talked about joint work on orbiting space stations such as Salyut and Skylab. He does not expect a Soviet moonlanding expedition for "five or six years"; instead, he stressed the need to find the physiological and mental capacity of humans for weightless flight—their limits and special needs. Indeed, he thinks Soviet space planners are more cautious about long-duration space flight than the Americans, and he has reservations about American plans to proceed directly from a 28-day Skylab mission to a 56-day one.

The exchange of satellite data and photographs between Washington and Moscow weather centers is already helping meteorologists in both countries deal with weather forecasting problems; its smooth working is one of the small successes that form a solid basis on which to build the growing Soviet-American scientific cooperation. The cloudscapes which Eugeni G. Popov, Deputy Director, showed us at the Hydrometeorological Service headquarters in Moscow looked remarkably like Tiros or Nimbus pictures, but there are important differences. "Our American colleagues like our pictures because of their better resolution due to their relatively low orbit," Dr. Popov told us; and the Russians value the American pictures they receive because of their wide coverage of the globe, particularly the vast expanses of the oceans.

The Soviets have enthusiastic praise for the extensive close-up photography of Mars accomplished by America's Mariner 9—and Academician Petrov noted that the Soviet craft, Mars 2 and Mars 3, did not repeat but instead supplemented

"No. You must ask the sensitive questions. This will be expected."

the Mariner coverage. At the same time, American planetary experts are as elated as Soviet scientists to learn from the Venera 8 capsule something of the composition and strength of Venusian rock.

"It Is Impossible to Make Any Bomb With Lasers"

With warm hospitality and frank discussion, Igor Morochow, Vice President of the State Committee on Atomic Energy, and his colleagues tried to reassure us that more intensive cooperation on nuclear energy problems would be possible —and would be rewarding for both the U.S. and the U.S.S.R. At this point, the U.S. has far more installed nuclear generating capacity than the Soviet Union— because the latter's reserves of fossil fuels are very large and alternative power sources are not of high priority. But the Russians have nevertheless pressed ahead in nuclear research, and the U.S.S.R. can join the U.S. as an equal partner in those lines which are important for the future—breeder reactors, nuclear fusion, peaceful uses of nuclear explosives, and waste disposal and safety problems.

Experts on both sides agree, for example, that nuclear fusion presents one of the most promising opportunities for closer Soviet–American cooperation. Russia has great scientific strength here; laboratories in many countries, including the U.S., are following up a line of work pioneered under Academician Lev Artsimovich at the Kurchatov Institute, and closer joint efforts would only quicken the pace of development to the benefit of the whole world.

Standing before the experimental setup using nine laser beams at the Lebedev Institute—a research tool many American specialists have applauded from afar— Oleg Krokhin, deputy to Nicholai Basov as head of the Institute, laughed at American predictions that his group would within a year achieve a laser-induced fusion process. He said it will take at least another three or four years of hard work to build lasers of the energy and efficiency needed. "And we don't know what problems will arise," he cautioned.

Under these circumstances, Krokhin said, he couldn't imagine military implications. But some American work on this subject has been classified under the claim of relevance to weaponry; this residual secrecy rankles physicists, and Krokhin considers it absurd.

Russia is moving ahead in the use of nuclear explosives for peaceful purposes, including explosions to shut down gas well fires, to dig out a river diversion canal, and to form an artificial lake. This experience could be important when —and if—the U.S. is ready to use nuclear explosives as engineering tools.

A Total Greater Than Its Parts

Americans have no monopoly on secrecy. A Soviet science writer who was one of our hosts on the 17-day Russian tour admitted that secrecy in the Russian space program bothered him as much as it does the U.S. He several times quizzed us about the many arrangements which N.A.S.A., industrial companies, and universities make to inform the press of the details of American space projects, and we promised to send him some of the mountain of briefing materials which will be supplied to the press during the forthcoming Apollo 17 moon mission.

He was optimistic: "I think this will change," he told us. "As cosmonauts train with your astronauts, as our people go more and more to see how you do things at Cape Kennedy and at Houston, when they see how you treat the press, I think they will begin to loosen up." One trouble: "They don't know what to do. They don't know how to deal with us. What you do in informing the press about your space program will help us develop an information system here." Hence his interest in the Apollo 17 materials.

The Russians do not lack for research tools. But Stanislaw Fedorovich Kozlov, who works with semiconductors at the Lebedev Institute, says some American items are particularly good. He looks forward to the day when he can feel free to deal with American suppliers as he now does with French or Japanese manufacturers—to say nothing of the day when he can have more intimate contact with American colleagues.

American science and technology would not starve for lack of greater access to Soviet laboratories. Nor would Russian research falter if it gains no further closeness to American work. But there is great promise in the agreements developed from President Nixon's visit in Moscow: the possibility to create something more than a simple addition of two national efforts, to evolve truly joint projects of a kind and quality that don't exist in a mere exchange of data and designs.

Will the secrecy and distrust really diminish? I asked my Russian colleague.

"I cannot be sure," he replied. "But I begin to see a few green shoots in the frozen ground. If we cultivate these, if we don't expect too much but cherish each sprout—I think eventually we will have a garden."

"... closer joint efforts would only quicken the pace of development to the benefit of the whole world."

As Science Editor of the Christian Science Monitor, *Robert C. Cowen has contributed to* Technology Review *regularly since 1966. The report above is excerpted by permission from a series written by Mr. Cowen for the* Christian Science Monitor. *Copyright 1972* The Christian Science Monitor Publishing Society; *all rights reserved.*

Wanted: Prescience on Technology

Washington Report: Victor Cohn

Congress has finally acted to try to prevent future shock, but in so doing it has made hardly a ripple in this jaded city.

This is often the way. Vandals and scandals make most of the headlines. The nation's front pages often chronicle the real and threatened disasters to man and the environment said to be heedlessly triggered by new technologies.

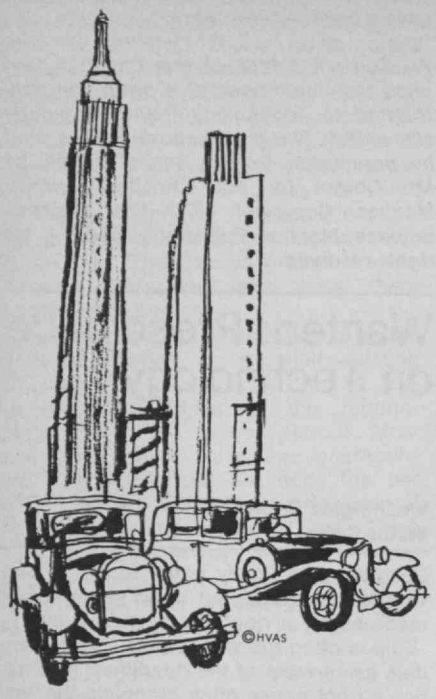
But the serious attempts to foresee such changes usually claim less attention, unless they are accompanied by a clutch of Herman Kahnian forecasts of an eye-popping future.

Fears of poisonous pesticides and other chemicals have gripped the public since Rachel Carson sounded the alarm over D.D.T. Yet the Congressional see-sawing of the last two years over a new pesticide control law, the first in 25 years, was one of the least-covered Washington stories. This neglect helped affect the outcome: we have a better law than the old one but not nearly as good a law as the problem deserves.

The intricacies of the legislation to help clean the nation's waters were generally tucked into inside pages until President Nixon's mid-October veto, which was promptly over-ridden by huge, bi-partisan margins. The new water law which thus emerged is not a bad one, but it is not as good as it could have been were press and public interest in cures as great as in disease.

Our streets and highways are clogged, but an effort to let cities use even a share of their federal highway construction money to improve mass transit died in the last hours of the Congress. On the surface, the effort was a victim of the last-minute crunch caused by the legislators' understandable zest to adjourn at least a few weeks before Election Day. But the underlying illness was that not enough people cared—or even knew of the issue.

Another example: we are constantly pressed by news of this or that dangerous product, but this year's struggle in Congress to work out the administrative details of consumer protection went largely unnoticed. In the end the Senate had to concur in a weaker House bill because of what on Capitol Hill appeared to be the voters' apathy.



"... the task of predicting what may happen across a broad spectrum of effects hard to measure even with hindsight."

Given these weaknesses of the press—and the competition for space and attention of the Watergate scandal, the war, Presidential polls, and the local political campaigns—no one expected Congressional action to create a new agency to prevent at least some "future shock" to be a cliffhanger. And it was not.

Yet the agency that Congress voted has the potential to become a major new force in the land.

Giving Congress Technological Clout

The action I write about was Congress' establishment of its own Office of Technology Assessment.

The subject of technology assessment—a clumsy phrase for which no one has yet found a good substitute—has been around for some years. Several universities already offer courses or seminars in it, and conferences have been held on the subject by lofty organizations as N.A.T.O. and E.E.C., the European Economic Community. Indeed everyone seems to agree that we sorely need to look harder at the possible human, social, economic and technological effects, good and bad, of new technologies.

Such an effort was first urged in Congress six years ago by Rep. Emilio Q. Daddario, the science-minded Connecticut Democrat who left the House in 1970 to run in vain for his state's governorship. The National Science Foundation launched some pilot studies. But an assessment agency to serve Congress, Daddario argued, must be controlled by Congress. "Congress has always reacted to the technical initiatives of the executive branch," he explained. "We just haven't had the capacity to evaluate them. We've often had no choice but to swallow a new project whole or reject it entirely."

Despite scores of studies and articles, the idea nonetheless went no place in Congress until this year. One Senate aide thinks two issues helped convince Congress this year—the A.B.M. and the S.S.T. In both matters Congress had "no really authoritative expertise of its own," the aide said. "Something was obviously needed with the authority and independence of the G.A.O."—Congress' effective General Accounting Office, which scrutinizes executive agencies.

House backers—mainly the Science Subcommittee once headed by Daddario and now chaired by Rep. John W. Davis—received some not entirely unselfish aid from Rep. Jack Brooks of Texas. Rep. Brooks chairs a Joint Committee on Congressional Operations which has few jobs, and he apparently saw a new role for himself in overseeing the new O.T.A.

Rep. Davis, like Sen. Daddario, preferred an O.T.A. under a board with Congressional and public members. Rep. Brooks successfully added a House amendment to make it a 10-member purely Congressional board, with majority party control—a sure way to pure partisanship—and it was this bill which passed the House last February in a 256-to-118 vote.

Sen. Edward M. Kennedy and his National Science Foundation Subcommittee produced the Senate version. Rules Committee Chairman Everett Jordan and Sen. Gordon Allott, a member of an N.S.F. appropriations subcommittee, helped push it. Neither party's leaders opposed it, and the bill passed the Senate in mid-September in a unanimous voice vote. The Senate specified that O.T.A. would be supervised by a six-member Congressional board, half from each party, assisted by a public-member advisory council.

The Senate version won out. O.T.A.'s director is to be named by the board for six years, though he can be removed earlier—in contrast to the secure head of G.A.O., who is named by the President for a 15-year term with almost certain tenure.

Predictions Without Hindsight

O.T.A. will begin with a two-year, $10 million budget and a staff of around 15. This is not a large group, but the outfit obviously has to begin someplace, and the staff could soon grow to 100. Also, O.T.A.—unlike G.A.O.—is expected to depend mainly on contracts with outside study groups: universities, companies, research centers, "think tanks," government agencies.

O.T.A. will not tell Congress what to do about anything. It is simply to report on likely consequences and alternatives.

In trying to do so, it will obviously operate under several handicaps. It will be subject to political pressures. If it probes subjects or issues reports that anger powerful legislators, it could soon be emasculated. And its director will not have the independence of G.A.O.'s. But if he is a strong man—this will be all-important—he may just act with independence, in which case it might be very difficult for at least a fairly evenly divided Congress to torpedo him. G.A.O. has gradually become a powerful watchdog of both Democratic and Republican administrations despite the fact that it, too, is quite clearly a Congressional servant.

A more basic problem is that G.A.O. looks at easily measured things that already have happened, mainly adding hard dollars and cents to make its assessments. O.T.A. will face the more difficult—perhaps impossible—task of predicting what may happen across a broad spectrum of conjectured effects hard to measure even with hindsight.

Still, most students of science and government believe the start must be made.

Not all agree. Some argue that Congress does not lack information on new technologies; it lacks only the political will to use the information it already possesses. Perhaps. But any newspaperman who covers Congress knows that it does indeed need more adequate information sources free of pressure from both the executive and individual legislators. Too many current Congressional opinions are based on "studies" whomped up overnight by highly partisan assistants mainly concerned with advancing the legislator they serve. A strong opinion from a truly competent O.T.A. could be something very different.

Victor Cohn, formerly Science Editor of the Washington Post, *is now concentrating on major science-oriented reporting assignments for that paper.*

Is Interest Turning Away from Science?

Victor K. McElheny

Is science news in eclipse?

Yes. Though great developments and activities of real human interest are still reported, it is easy to argue that one manifestation of the "turning away" from science of the past few years is a decline in journalistic coverage. Several leading newspapers are doing without science editors. The television series, "21st Century," no longer runs on C.B.S. In New York, N.E.T. no longer produces its own "Spectrum" shows for public television.

The situation has features which—in the short run—newsmen welcome. Like other journalists, science reporters look at their field with professional skepticism. They do not cherish the old-style breathlessness about science; they feel their job can be done better without it. They are glad enough to be released from attendance at the latest ego-trip to the moon.

His new-found freedom to serve himself and science—instead of the headline writer—almost compensates for the science writer's increasingly difficult fight for space for his science story; his struggle is especially difficult if his story concerns a basic discovery remote from application to a human need or from the dreary turns of politics.

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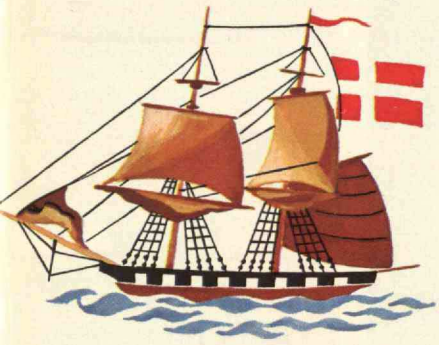

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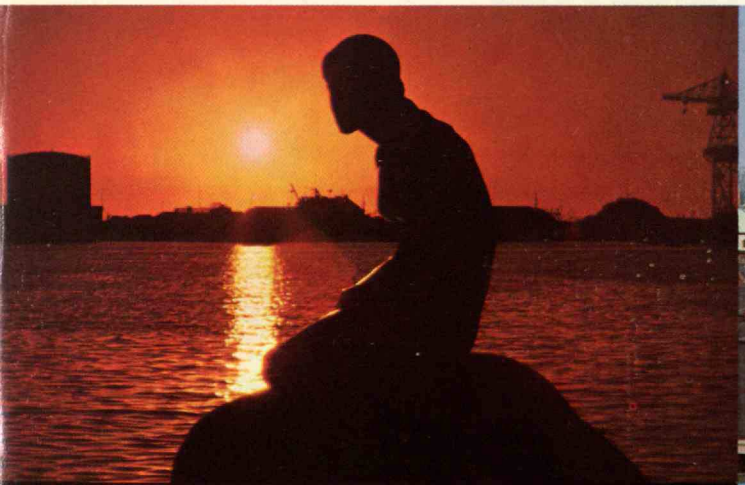

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In Copenhagen, our accommodations are twin-bedded rooms at the Danhotel, an ultra-modern, first-class hotel, one of the largest (272 rooms) in Denmark. Our rooms will all have radio (television available at a nominal charge), telephone, and private bathroom with shower; they are impeccably clean, small in the typically Scandinavian fashion, and furnished in sleekly contemporary Danish-design teak furniture. The Danhotel has complete facilities including two lovely restaurants, a lively bar, and a shopping arcade; it is less than ten minutes by taxi from the center of Copenhagen's shopping area (a city bus departs every fifteen minutes from the front of the hotel). The Danhotel's gracious service is considered by many to be the best in Copenhagen.

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COVER PHOTOS: (1) Hans Christian Andersen's Little Mermaid; (2) Copenhagen by day; (3) Copenhagen by night; (4) Royal Guard at Amalienborg Palace.

The ultra-modern Danhotel


One of Danhotel's restaurants


A typical hotel room


Ströget, Copenhagen's famous pedestrian shopping street


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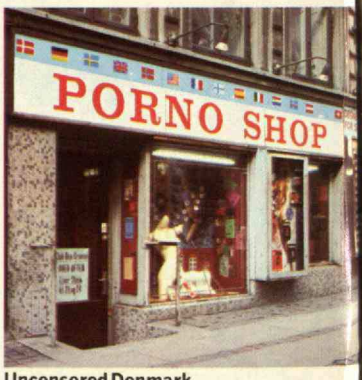

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2 On arrival in Copenhagen's Kastrup Airport, we are met by our International Weekends hostesses and transferred by deluxe motor coach to the Danhotel where our keys are waiting (no "checking in"). Luggage goes directly to our hotel rooms.
This evening, an illuminated sightseeing tour of Copenhagen, followed by a fabulous show (and glass of wine, beer or tonic) at Lorry's, Copenhagen's famous nightclub.

3 After our usual Danish pastry and coffee, we are off for a half-day of sightseeing in Copenhagen. The tour will conclude with a visit to the Carlsberg Brewery where we shall have all the delicious beer we can drink. The remainder of the day is at our leisure.

4 After breakfast, the day is at leisure until evening. We might stroll along Ströget, Copenhagen's world-famous pedestrian shopping street and stop in at Illum's, Copenhagen's queen of department stores, which has invited us to be its guests for coffee and pastry.
This evening, we have parterre or balcony tickets for the Royal Danish Ballet at the Royal Theatre.

5 After breakfast, our day is at leisure until suppertime. Then, save your appetites, we have a sixty-dish Scandinavian Smorgasbord Banquet this evening at one of Copenhagen's best restaurants with all we can eat of delicious Danish food.

6 & 7 After breakfast, these days are at leisure. Some may wish to take an optional side trip (see back of folder) for a day in Stockholm, capital of Sweden.

8 After breakfast, bellmen take our luggage from our rooms, and we are driven to the airport for the return flight. Throughout the return flight, our Scandinavian hostesses will keep us well fed and pampered.

The precise schedule of events in this itinerary is subject to change.

Sightseeing Galore

Two sightseeing trips (one in the day and one in the evening) will take us to the important places of Copenhagen including the Carlsberg Museum and Brewery with all the beer we can drink, Amalienborg Palace (residence of the King) where we'll see the Changing of the Guard, Christiansborg Castle (housing the Danish Parliament) with its Theatre Museum, the Little Mermaid (erected in tribute to Hans Christian Andersen), The Royal Opera, Bellahöj with its panoramic view of Copenhagen, The Royal Copenhagen porcelain factory, The Academy of Arts, the world's first Stock Exchange, The Flower Market, the State Museum of Arts, the Old Fish Market, the exquisite Town Hall Square, the Zoological Gardens (with over 2,500 animals), the National Museum (fascinating exhibits on the history of man, especially the Danes), Frederiksberg Castle (now a military establishment), the Law Courts, the University of Copenhagen, and much more...

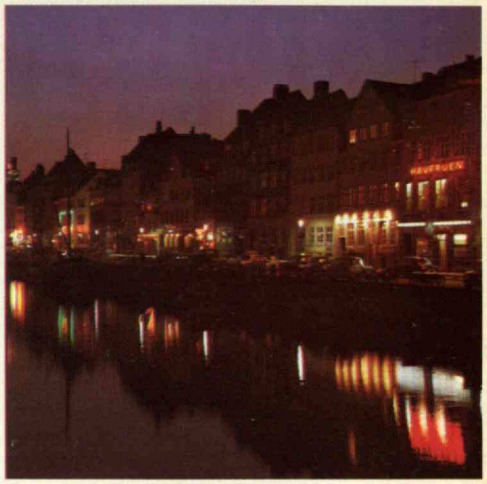
Royal Danish Ballet

One evening, we have parterre or balcony tickets at the exquisite Royal Theatre for a performance of the Royal Danish Ballet, one of the world's truly great dance companies and the pride of Denmark.

An Evening at Lorry's

One evening, we are invited for a glass of wine or beer (or tonic, if we prefer) at Copenhagen's most exciting nightclub, Lorry's, where we shall dance and see a fabulous nightclub floor show. Over two hundred years old, Lorry's is a multi-faceted entertainment complex which has become a Danish institution known 'round the world.

World-famous Lorry's



The notorious Nyhavn quarter

Danish breakfast

Each morning during our stay, we shall have a delightful Danish breakfast consisting of delicious Danish coffee and Danish pastry baked in Danhotel's own pastry kitchen. A lovely way to start each day.

Smörgåsbord Banquet

One evening, we shall partake of a fantastic gastronomical experience. At one of Copenhagen's best restaurants, we shall enjoy a sixty dish gourmet banquet, exposing us to the breadth and delicacy of Danish cooking . . . all we can eat of everything from caviar to roast beef.

A Treat at Illum's

Whenever we wish during our stay, we are to be guests of Illum's, the Queen of Danish Department Stores, for Danish coffee and pastry. Illum's is a magnificent edifice to fine Danish furniture, fashion, china, housewares and design.

THE PRICE AND WHAT IT INCLUDES: The price stated on the front cover of this folder includes round-trip jet transportation between the city of departure and Copenhagen, tranfers of persons and porterage of luggage between the airport and the hotel, twin-bedded room accommodations on a double occupancy basis in a first-class hotel, a breakfast each morning consisting of coffee and Danish pastry, bus sightseeing of Copenhagen, one smörgåsbord dinner, one ticket (parterre or balcony seat) to the ballet or other performing arts event, admission and one glass of wine, beer or tonic at a nightclub with show, coffee and pastry at a department store, a visit to a brewery, the services of a tour escort, and all taxes, tipping, and service charges with respect to these items. The items enumerated in the next preceding sentence are expressed in general terms, because the tour operator reserves the right, without having to refund any monies to passengers, to alter, change or make substitutions in the itinerary of the trip and the features which comprise it, provided that such alterations, changes, or substitutions do not diminish the aggregate fair market value of what is to be included in the price of the trip. The phrase »Tax and Service«, as used in this folder, means and includes all taxes, tipping and service charges of whatever nature pertaining to the items included in the land portion of the trip.

SINGLE RESERVATIONS: The price stated on the front cover of this folder is on the basis of double occupancy of a hotel room. Single accommodations require a $ 49.00 additional charge.

DOCUMENTS: Each passenger must carry a valid passport. A certificate of smallpox vaccination issued within the preceding three (3) years is recommended but not required.

ELIGIBILITY: Participation in this trip is limited to those members of the sponsoring organization who will have been members for at least six months before the departure date, their husbands or wives, their dependent children, and their parents if living in the same household.

LUGGAGE: Each passenger aboard the aircraft is permitted up to 44 pounds of baggage, subject to the restriction that there be no more than one suitcase plus one carry-on piece per passenger. Baggage (luggage) travels throughout the trip (air and land portions) strictly at the risk of the passenger, and the tour operator shall not be responsible or liable, and expressly disclaims all liability, for any loss, damage or expense occasioned by the loss of, delay of, or damage to any passenger's baggage (luggage) or its contents. Baggage (luggage) insurance, at a nominal cost, is available and recommended.

FINAL PAYMENT AND CANCELLATION: Payment of final balance is due 60 days in advance of departure (at which time reservations will be confirmed). Reservations may only be cancelled by written notice sent by registered mail to the Travel Agent. If such written notice is received by the Travel Agent no later than sixty (60) days before departure, the Travel Agent will accept the cancellation and refund all monies. If such notice is received within sixty (60) days before departure, the Travel Agent will accept such cancellations and refund monies only if the cancelling party finds eligible substitute(s) for the reservation(s) being cancelled. Cancellation insurance (protecting against the loss of air fare) will be made available and is recommended.

INSURANCE: In addition to the baggage insurance mentioned elsewhere, ordinary travel insurance is available for those who wish it.

Optional Side Trips

Here are a few of the inexpensive optional side trips you may purchase:

GAMBLING AT ELSINORE
An evening of gambling at the Hotel Marienlyst Casino in Elsinore, where you can wager as little as 15 c.

COPENHAGEN'S NAKED TRUTH
A nighttime tour of Copenhagen's pornographic area and the notorious Nyhavn district, followed by a visit to a »live show« at one of Copenhagen's sex clubs.

A DAY IN STOCKHOLM
Fly to Stockholm, capital of Sweden where you spend a day of sightseeing and other fun and return to Copenhagen the same evening.

VISIT TO DENMARK'S »DISNEYLAND«
A trip to the fantasmagorical world of Legoland, Denmark's »Disneyland«, where the magic of Denmark is captured in brightly colored miniaturizations and exciting rides.

VISIT TO HAMLET'S CASTLE
An afternoon trip to Kronborg Castle, legendary palace of Hamlet, Shakespeare's Prince of Denmark, set majestically on the cliffs of Elsinore above the Baltic.

H. CHRISTIAN ANDERSEN TOUR
A day-long trip by bus and ship to Odense, the village of Hans Christian Andersen.

A DAY IN OSLO
Fly to Oslo, capital of Norway, where you'll spend a day of sightseeing and return to Copenhagen the same evening.

RESPONSIBILITY, ETC.: Each person making reservations for participating in the trip described in this folder understands and agrees to all the terms, conditions, and limitations set fo in this folder including the following: The air transportation f this trip is held out and engaged by the sponsoring organiza whose name appears on the front cover of this folder, which organization acts only as agent for the group of persons bei transported thereby. Except if and to the extent Internationa Weekends, Inc. (the travel agent) assists in arranging the ai transportation wherein the travel agent acts only as agent fo the sponsoring organization, the travel agent, in undertakin make arrangements with various persons, firms, and corpo tions for the provision of accommodations and services de scribed in this folder to be included in the trip, acts only as agent for such persons, firms, and corporations. In so acting as agent, the travel agent shall not be held responsible for, and expressly disclaims any responsibility or liability for, th failure of any person, firm, or corporation to provide any se or accommodations to be included in the trip which failure results from causes outside the immediate control of the tra agent. Further, the travel agent shall not be responsible or for, and expressly disclaims any responsibility or liability f any loss, cost, injury, expense, or damage to person or pro which results, directly or indirectly, from any act, whether negligent or otherwise, of commission or omission (including but not limited to delays), of any person, firm, or corpora tio which is to, shall, or does provide products or services in connection with the trip including but not limited to transp or tion services (whether by air, sea, or land), lodging, food an beverage, entertainment, sightseeing, luggage handling, o tour guiding or escorting. The travel agent reserves the right decline, accept, or retain, at any time and for any reason an person as a participant in the trip. If any person is remo ed the travel agent from the trip, a proportionate refund for n services will be made. The travel agent reserves the right t cancel the entire trip for any reason and at any time befor departure, in which event the liability, if any, of the travel a shall be limited to refunding to each prospective participan the monies paid to the travel agent by such person for the trip, which monies have not been or will not otherwise be refunded to him.

For your information, the price of this trip is constituted as follows: air fare, $127.34 per person; land arrangements, $88.06 per person; administration, $3.50 per person; Total price, $218.90 per person. The air fare stated above is a pro rata cost to each of 194 passengers; should there be fewer than 194 passengers, each passenger may, at least forty-five days before the departure date, be notified of any increased pro rata cost to him and will have the option to pay the difference or cancel without penalty.

Final payment of balance is due in advance of departure immediately upon being invoiced therefor.

The aircraft being utilized in conjunction with this trip is a jet with seating for 194 people. Reservations applications will be processed strictly in order of their receipt by the tour operator, with a waiting-list maintained for any reservations in excess of 194. All reservations applications must be mailed, in all events, before the reservations deadline set forth below.

DEADLINE FOR RESERVATIONS:

FEBRUARY 5

TO:
M.I.T. Cop. Trip
c/o International Weekends
156 State Street
Boston, Massachusetts 02109

MY CHECK IS MADE PAYABLE TO:
International Weekends, Inc.

DEPARTURE DATE:
March 22

Enclosed is $_____ ($100 per person) as deposit for _____ reservation(s) on the Copenhagen trip, subject to the terms stated in this folder.

NAME (last) _____ (first) _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

TELEPHONE (9—5) _____ (after 5) _____

I have enclosed a list of the names and addresses of the others in whose behalf I am making reservations.

SA323

Land arrangements made by
INTERNATIONAL WEEKENDS, INC.
The Group Travel Specialists
156 State Street
Boston, Massachusetts 02109
Telephone 617/723-9600
TELEX 94-6358

"The fact is that scientists have more influence on their society today than ever before—and the society has more influence on scientists."

But a decline in public attention for science arouses basic anxieties in the scientific community. Many scientists silently harbor a fear that the growth of knowledge will somehow, someday, be halted when its patrons suddenly become uncomprehending and disillusioned. Perhaps the leveling-off of U.S. government spending for research and development in the past few years is the harbinger of some permanent loss of favor?

A Golden Age of Science

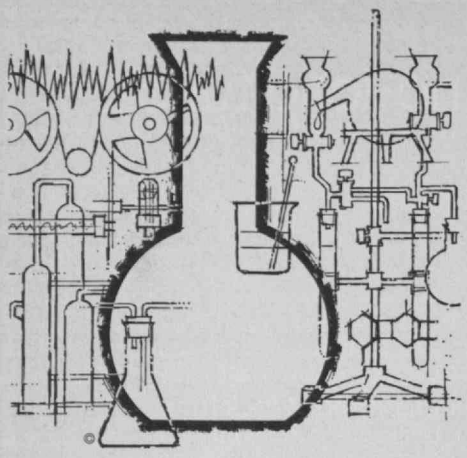
Such pessimism hardly seems warranted in a golden age of science like the one in which we live. Ours is a time of enormously expanding mental horizons, a time whose glory may be as great as that of Elizabethan England. Indeed, western civilization as a whole has been dominated for the past 300 years by scientific discovery.

People may say as often as they like that they are "turning away" from science. But during those 300 years, how much "faltering" of the sort discerned lately has there been? Not much. The doubling of the number of scientists at work has gone on every 10 years for this entire period. If there was faltering in the application of science in Britain around 1850, after 100 years of unceasing industrial revolution, the initiative passed effortlessly to Germany and the United States. Yet Britain has maintained its eminence in fundamental science down to the present day. In France, not even the supposedly paralyzing authoritarianism of the "university" system devised by Napoleon could stifle the investigative genius of Pasteur or prevent the application of that genius to save such industries as brewing, chicken-raising, or wine-making—and most nobly of all, to save lives. If Jacques Monod was unable to find proper support for his studies in France, he was able to study at the Olympian California Institute of Technology and receive funds from the National Institutes of Health and the Jane Coffin Childs Memorial Cancer Fund. If Hitler's Germany scorned its greatest intellectuals, there were Britain and America to cherish them. If America were to falter, other countries would probably pick up the pace.

Impossible but Inevitable

In any scientific civilization, talking to the general public about science can seem impossible. There are too many important things to communicate, and scientific discoveries involve a complex background which is not part of the traditional basic education.

There are other problems, too, which make communicating science to the public seem as impossible as it is inevitable. There seems always lurking in the background a kind of folk suspicion



"We are in the midst of a golden age of discovery, and we would do well to think harder about communicating the joy of this discovery."

that science is allied to the black arts: chemistry is the daughter of alchemy. Science is constantly eroding popularly held convictions. Science, too, is the cause of constant economic change which can swiftly render a whole class of people irrelevant or subject them to an unpleasant new discipline.

And yet it is inevitable that scientists increasingly talk to their fellow-citizens about their discoveries. Escape from the task is as impossible today as it was for Galileo, whether he worked for the skeptical Republic of Venice or the devout court of the Grand Duchy of Florence. Why?

First of all, there are so many more scientists. The world scientific community has undergone three doublings in the last generation.

Second, the means of communication to the public have multiplied in number and intensity—and this process will continue.

Third, there has been a marked increase in the leisure time for paying attention to what is communicated. Television, the prime medium, demands attention; and people have time—hours every day—to give it.

Fourth, the interplay between scientific discovery and the facts of everyday life is intensifying. Civilization in fact finds itself in an increasingly intimate and conscious relationship with the sciences for the achievement of its highest goals.

Science as a Social Force

The intensity of change brought by technological advance is increasing. From the long historical point of view, the bicycle, the automobile, the airplane, and the rocket were developed virtually simultaneously. Mass production of bicycles began in the 1880s. In the 1890s, bicycle makers and carriage makers were running automobile races which established the primacy of the internal combustion engine. Just after 1900, two bicycle makers flew a heavier-than-air flying machine. The first liquid-fueled rocket took off from Massachusetts in 1926, just a year before Lindbergh made the first solo flight across the Atlantic. The first national network of four-lane expressways in the United States, the interstate highway system, was hardly more than half complete when two Americans stepped on the moon.

Meanwhile, military power based in science also increased in an unending procession—radar, sonar, computers, atomic and nuclear explosives, submarines and rockets.

But however terrible is the threat that the American and Russian arsenals of nuclear missiles would be discharged in a spasm of fear, however great the resources devoted to building these arsenals, they have not stopped the great humanitarian achievements of a golden age of science: The conquest of malaria and other infectious diseases throughout the world; new food grains to provide mankind with an adequate supply of calories; the development of reliable, simple methods of birth control to meet the needs of a world where (for the first time in man's history) the majority of babies born live to maturity.

Scientists interact increasingly with the world society in which they are more and more visible as a social force. The fact is that scientists have more influence on their society today than ever before—and the society has more influence on scientists. The often-bruising contact between cultures represents education. So the interaction of scientists and society breeds a more knowledgeable interrelationship—more rational political and social opposition to some science-based projects, and more scientific opposition to the maneuverings of politicians. The supposedly untouchable scientific priesthood becomes increasingly accountable to its patrons, the citizens. Likewise, politicians become increasingly accountable to scientists (as to other pressure groups).

Science, Society and Discovery

There is an example from the field of nuclear weapons: from the moment of the first—and only—military use of the atomic bomb on Hiroshima and Nagasaki, the world community of scientists has campaigned to force governments to one disarmament step after another (even if those steps appear modest in comparison to the accumulation of arsenals beyond all reason). Scientists have been a consistent, informed opposition to unjustified weapons commitments. The very people who invented the bomb have insisted ever since on having some responsible voice in controlling it. They have never resigned the field to the military.

Similar counterpressures have operated in many other fields—so many, in fact, that this pattern can be regarded as typical for the scientific community. Public health researchers early became concerned about massive "overkill" with pesticides (even as they conquered malaria). Physicists have stepped forward to pick holes in the Atomic Energy Commission's process for developing and enforcing safeguards against catastrophic loss-of-coolant accidents in nuclear power plants.

If there is indeed an eclipse of science news today, it can only be partial—and temporary. But there is a hazard.

For when science news struggles for readership, its writers often succumb to the temptation of emphasizing "relevancy" and stressing the pragmatic in scientific advance. In the midst of a golden age of discovery, we do well to think harder about communicating the joy of this discovery. For discovery is one of the truly liberating forces of our times.

For the individual there is no firmer guarantee of personal autonomy and liberty than a career of discovery; it is a built-in antidote to the discipline and monolithic conformity that can be produced as much by the complexities of a machine-based society as by the needs of an agricultural one. For a society, too, discovery is an assurance of freedom and ferment.

There is no dearth of things to be discovered. There is no dearth of new frontiers, both pleasant and unpleasant, where surprises lie waiting to challenge established thought, and hence to erode crushing social structures.

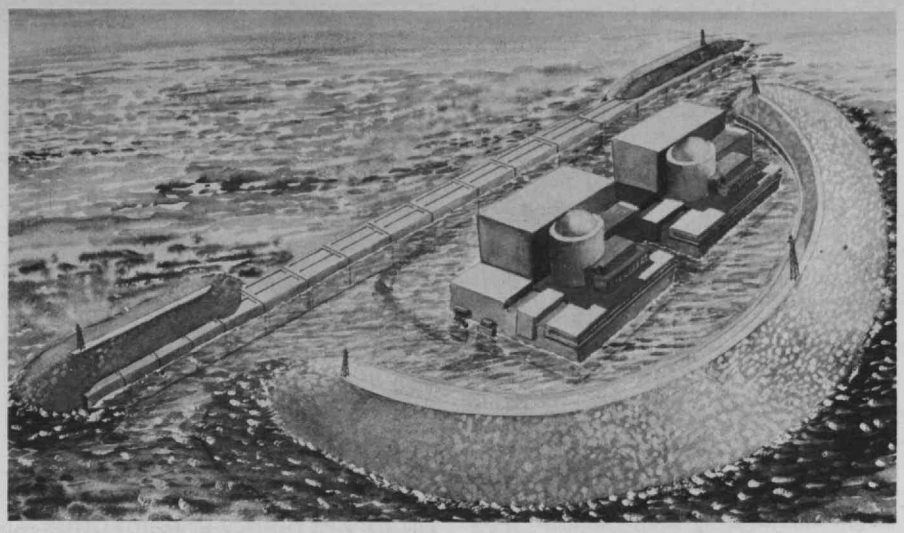
Victor K. McElheny, formerly European correspondent of Science *and Science Editor of the* Boston Globe, *is a freelance writer based in Cambridge, Mass.*

Nuclear Power Going to Sea

Peter Gwynne

Hand in hand with reminders of the energy crisis facing this country comes evidence that all is not well with its techniques of producing energy. On the one hand, environmental pressure has seeped through to just about every part of the power industry, greatly restricting the choice of sites for new power stations; even now the Atomic Energy Commission is embroiled in acrimonious debate with a number of environmental groups over the safety of cooling systems in currently operating nuclear plants. On the other, promising alternative technologies for generating energy either have too limited an application or require too long a lead time to produce any great impact on the country's power picture in the next couple of decades.

Perhaps the only way out of the morass is to put a new environmental wrinkle on an established technology, and that is precisely what Public Service Electric and Gas Corp. of Newark, N.J., has done. Last fall, on a yacht moored some 11 miles northeast of Atlantic City, just inside New Jersey's three-mile territorial water limit, the company signed a $1.1 billion contract for a massive nuclear reactor complex that will be moored in 45 feet of water close to the site of the signing.



The crucial issue in the feasibility of the offshore nuclear generating station now being planned by Offshore Power Systems for Public Service Electric and Gas Corp. of New Jersey is the success of two breakwaters. This resolved, the plan appears to threaten less environmental impact than any other system presently proposed to meet the growing power needs of the industrial northeast.

Science Fiction or Technological Fact

Although at first glance an offshore floating power station may seem to be an incongruity more suited to science fiction than technological fact, the concept has a number of advantages over land-based plants, nuclear or otherwise:

☐ Most obvious is the ready availability of water for cooling purposes—an increasingly elusive commodity for land-based plants.

☐ Just as critical is the likelihood that a nuclear plant surrounded by seawater will be inherently safer than one on land; its distance from population centers will almost certainly be greater than that of a land-based plant, and its watery surrounding should serve to dilute any radioactive material that might escape from the reactor in the unlikely event of an accident.

☐ There is a third somewhat paradoxical advantage for offshore plants: they could satisfy the power needs of a large percentage of the U.S. population. At present some 14 per cent of the nation's electrical power is expended in a 150-mile-wide strip of land along the eastern shore between Boston and Washington—an area well within delivery range for offshore plants—and census figures show that 42 per cent of the population lives within 200 miles of a coastline. With numbers such as these, one can imagine that a string of offshore power plants located along the Atlantic, Gulf and Pacific coasts, together with plants in the Great Lakes, could supply a vast proportion of the nation's energy needs by the end of the century.

Taming The Sea

This certainly is the dream of the most bullish proponents of offshore nuclear power, such as Alexander P. Zechella. Mr. Zechella is General Manager of Offshore Power Systems, a joint venture of Westinghouse Electric Corp. and Tenneco, Inc., formed with the express purpose of building reactors for offshore plants: "We see the offshore nuclear power generating station as the only logical answer to power shortages in coastal urban areas, and we are preparing to meet this need during the coming decade." To do so, Mr. Zechella's company has settled on an island near Jacksonville, Fla., where it will mass-produce floating reactors; and having signed the first contract with Public Service, Offshore is now aggressively seeking new customers, particularly among the harried power companies that serve the northeast.

Although delivery of the two reactors for the New Jersey complex is not scheduled until 1979, it is clear that the success of the operation depends on decisions to be made in the next few months. Offshore has made it clear that it needs a steady stream of two orders per year to operate economically—indeed, to operate at all.

The New Jersey offshore reactor, if and when it comes about, will be a veritable dictionary of modern technology. At its heart will be two 1.15-million-kilowatt nuclear reactors sitting atop rectangular, floating, platforms 400 by 387 ft. The reactors will be assembled at Jacksonville, towed to their offshore site, and there connected with the mainland via high-voltage cables buried in the sea bed.

But the most important part of constructing the complex will take place at the site itself—the assembly of two massive breakwaters around the plant to protect it from hurricanes, tidal waves, earthquakes, shipwrecks and other natural and unnatural disasters. This protection will undoubtedly play a critical role in the Atomic Energy Commission hearings on the concept which will probably get under way next year. "The feasibility of the entire project", says Public Service President Edward R. Eberle, "hinges on the breakwaters."

The seaward breaker will, of course, bear the brunt of any pressure from sea or climate, and it is designed to withstand the sort of hurricane force expected in the area just once in a century. The structure will be based on a series of concrete caissons which will be built at a site on shore, floated out to the reactor complex, and sunk into the seabed. On the seaward side of the caissons engineers will dump layers of sand, gravel and stone to form a kind of shelf facing out to sea. Finally, the structure will be covered on its seaward side with pieces of concrete rubble, designed to give the seawater hundreds of spaces in which it can slosh around and disperse its energy. The result will be a sloping structure planned to withstand winds as high as 300 miles per hour, impacts of the largest supertankers on the ocean or the drawing boards, and waves cresting 50 ft. above the normal sea level.

This structure will be complemented on the landward side of the reactor complex with a linear wall 2000 ft. long and protected at its ends in the same way as the seaward breaker. The two structures will form an artificial lagoon for the floating nuclear plants, with narrow passageways between the breakers through which boats can enter to service and supply the complex.

An Aesthetic Threat

Environmentally, the proposed plant appears to have a number of features that will disarm critics of land-based plants. For example, the impact of thermal pollution is likely to be well below that from nuclear plants that use river or lake water. Public Service consultants forecast that the rise in temperature will be no more than 5°F. over an area of five acres close to the plant's water outlet; plants sited on rivers, by contrast, generally produce a plume of water between 10° and 20°F. above its surroundings that stretches for miles. Certainly, environmentalists concede this aspect of the offshore power concept.

But local interests in New Jersey have taken Public Service to task for presenting them with an aesthetic threat to their tourist industry—Public Service claims that the lines of the station on the horizon will appear similar to those of a ship at sea—and have questioned some of the optimistic assessments by boosters of the proposed station. The clash between the two sides in the A.E.C. hearings on the concept may, for once, supply some much-needed light on the topic of balancing possible environmental hazards against this country's desperate need for more generating capacity.

Peter Gwynne, former Managing Editor of Technology Review, *is now Associate Editor of* Newsweek.

Reminiscence at Christmas

Volta W. Torrey

"Nature is still beautiful, men are mostly kind, life is worth living," Vannevar Bush, the "senior statesman" of the Massachusetts Institute of Technology, told its students last Christmas. "Go out, then into the world with the Christmas spirit!"

Has technology polluted everything? Are men still as kindly as ever? If not, why do so many people question our charity? Few persons did in our century's infancy.

The playground in Avoca, Iowa, where I lived, extended as far as the grocer's wagon went. Kindliness sparkled around us like a Christmas tree's many lights. The deliveryman had once been to California and had a pocketful of picture postcards to prove it. He would let you admire them, hold the reins of his horse, and wait if you hopped off to pick up a bottle in an alley. Then if you rapped on the saloon window and held up that bottle, a fiercely mustached bartender would step out to give you a penny for it.

Fast trains whistled through Avoca, and sacks of mail came bounding out of the mail car doors for us. Farmers hauled sweet corn from their fields to a tiny canning plant and tossed green ears from their open wagons for us to roast in bonfires. Along our main street, marks on the poles labelled it part of the transcontinental Lincoln Highway—but it was still a dirt road that the sheriff often closed in winter.

It never occurred to me how beautiful nature was until a fall evening when my dad and a neighbor came out to help us rake leaves. While we were browning marshmallows in flames from that foliage, the men debated which season was more beautiful, springtime or autumn, and made us wonder, too.

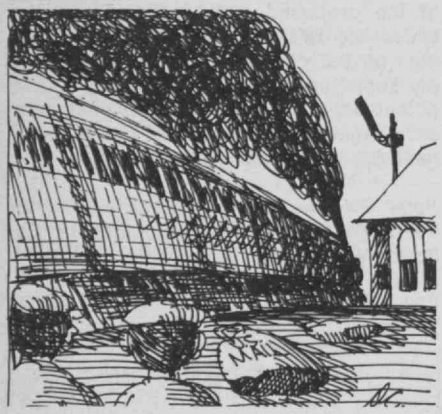
The Three "R"s—Inside and Outside

Every boy and girl I knew went to the same school. Members of our mothers' sewing circles taught 12 grades there. They seated us alphabetically and we helped each other learn to read. Later we recited lines from Hiawatha and explained the quality of mercy to each other in declamatory contests. We began Palmer penmanship by filling the space between two lines with overlapping O's, in step with the tapping of a teacher's ruler on her desk. When the school got a phonograph, she played waltzes while we wrote. The boys in the manual training class built the stand for that machine, and the principal paid for records by charging parents 10 cents to hear Enrico Caruso or Harry Lauder while the domestic science girls served coffee.

We found out about the third "R" outside as well as in that school. The big boys played marbles for keeps, which taught little boys to count. Many of them evened the score a year or so later in a poker club that met secretly in the church basement after choir practice.

There were no buses. If a boy could not walk, a playmate took him to school in a coaster wagon. If a girl could not dance, someone helped her learn to play a piano or a violin. A few farmers still had sleighs, but on stormy nights a farm boy usually shared my bed in town and read my Tom Swift or Horatio Alger books.

There was no gymnasium. The school's fire escape was a wide metal tube that ran to the ground from a second floor window at an angle you could slide down. On the first enticing day every spring, one of the boys would become a prince among his peers by leaping into that tube and being out of sight before a teacher missed him. A few mornings later some rival's initials might be chalked near the top of a water tank that we were forbidden to climb. Like the weather, juvenile delinquency was generally considered an uncontrollable, rarely unendurable, and usually seasonal fact of life.



"Fast trains whistled through Avoca, and sacks of mail came bounding out . . ."

Hearing the Corn Grow

Once in a farmer's field we saw a bull snake that was fat and six feet long. We clubbed it to death and ran proudly to the barn with its body hanging from a stick between us. The farmer swore because he had given a neighbor a dollar to let him move that snake into a field full of gophers. To punish us, he gave us spades and told us to see if we could dig through a mound in that field fast enough to catch a gopher.

In town, when we jumped on a jiggly platform at the flour mill, a man in white overalls showed us how to adjust things on a brass bar to weigh ourselves. If we pressed our noses against the jeweler's window, he might invite us into the store to look through his strange eyeglass at the tiny red gems in watches. The printer, too, would sometimes notice us—and set our names in type, then let us see them upside down in a metal frame.

Barnum and Bailey or Ringling Brothers papered our fences and barns annually with pictures of dare-devil acrobats and snarling beasts, but circus trains never stopped in Avoca. We set alarm clocks to see the gaudy wagons rattle through town on flat cars before dawn.

"They seated us alphabetically and we . . . explained the quality of mercy to each other in declamatory contests."

On many nights our lawn was so quiet that if a faint breeze rustled the cornstalks you could "hear" them growing. My father often sat on the edge of the porch with us then and talked about the sky. If lightning flashed, we counted seconds until we heard the thunder, to estimate how far from us it was. But astronomers could still only guess, Dad said, what happened long, long ago and far, far away, to send constellations of tiny lights slowly floating across our sky.

A young man home from the Navy strung wires above his backyard and let us hear mysterious buzzes in earphones for the first time. Soon many of us had clipped coupons from magazines to buy crystals and spools of fine wire for wireless sets. Then a garageman showed us how to use a sparkbox from the dashboard of a Ford car as a transmitter. Many of us that year conversed in code, after a fashion, from one end of town to another.

Even without a dime, you could get into the movie on Saturday night by being first in line to offer to rewind reels in the operator's hot tin closet. I became "it" in a money-making game the day a man from Omaha asked if I would like to have a newspaper route. We went from door to door together soliciting customers. At the movie he paid for a slide to be shown between the comedy and the next installment of "Perils of Pauline." To produce the slide he clipped two figures from a comic strip and changed the balloons to alter the dialogue. My playmates gasped when Mutt asked Jeff, "Can I get *The Omaha World-Herald* every day in Avoca?" and was told to see *me.*

The bundles left on the depot platform became heavy, especially on Sunday mornings, but the bagaggeman helped me handle them. Once a Rock Island railroad conductor pulled the emergency cord to stop a train so that a passenger could hand pennies out a window to me for a paper. The bank cashier stacked the coins I collected, made sure I could write checks properly, and accepted an account on which there was no service charge.

The only person who ever added a tip

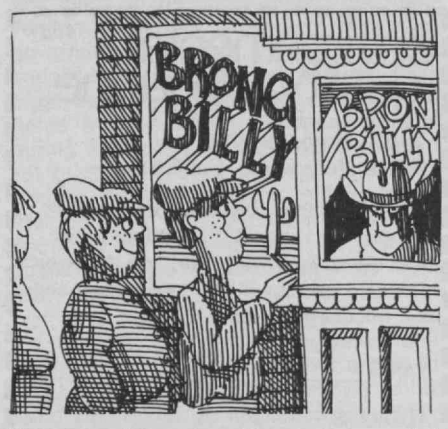
was a salesman from Chicago. But the man who ran a carnival merry-go-round let me enjoy extra rides while he read the sports page in one of my papers, then neatly folded it and put it back in my bag. And the lawyer who always asked why when I was late with his paper told me how to improve the punctuation in my school essay. My subject was "Why I Do Not Smoke," and it won a prize of five silver dollars that I used to buy a box of cigars for my father the next Christmas.

There was a grating in the ceiling above the hard-coal stove in our living room. Warm air rising through it to my bedroom often carried grownups' voices. One night when the minister lingered after supper, my father asked him how he had heard the Lord's call. He said he had seen the letters G-P-C in a dream and interpreted them to mean "Go Preach Christ." After the minister left, Dad said those letters must have meant "Go Plow Corn," and my mother gently slapped him.

Serving the Christmas Spirit

Are people generally as kindly now as then? My dad would concede that they sometimes seem less so, but would maintain that human hearts never can be permanently polluted—because of what happened on one of winter's longest nights nearly 21 centuries ago. And he would tell young skeptics on his knee, even more emphatically now, that there really is a Santa Claus who, as often as the Earth goes around the Sun, somehow or other finds a way into every child's heart.

A Rip Van Winkle, asleep since then and awakening in America now, would see and acclaim many changes. Trains no longer snort through small towns squirting cinders into children's eyes. Paved roads extend nearly everywhere. Mountains, seashores, and prairies are familiar sights to more people. More towns have hospitals. More homes have indoor plumbing. High-voltage lines have silenced the steam whistles of tiny power plants, and the land is strewn like the sky at night with clusters of glowing lights. TV antennas sprout everywhere, and even other planets seem less distant. The hazards and loneliness that men silently endured for centuries have been reduced. People who speak different languages are beginning to understand each other a bit better. Today's atmosphere of doom, Dr. Bush concluded, is an absurd disease that must be cured. Technology contributed to it, of course, but can serve the Christmas as well as any other spirit.



"Even without a dime you could get into the movie on Saturday night by being first in line to offer to rewind reels . . ."

Volta W. Torrey edited Technology Review *from 1959 to 1966; he is now associated with the technology utilization program of the National Aeronautics and Space Administration in Washington.*

Can Architecture Be Managed?

Book Review:
Lawrence B. Anderson
Senior Lecturer
Department of Architecture, M.I.T.

Architecture by Team
William Wayne Caudill
New York: Van Nostrand Reinhold Co., 1971, xviii & 346 pp.

The world's supply of buildings is constantly being increased by many separate projects, highly diverse in size and character. As a sample, neither so small nor so big as to be out of the ordinary, consider a project costing $10 million. Its physical components are inert stuff refined and specialized for many applications by something like 1,000 man-years of human effort. Some of this effort is embodied in manufacturing equipment and standard parts already stockpiled, but most is called into being by signals emanating from the project itself. Often castigated for its inefficiency, the building industry is nevertheless able to accomplish this remaining effort within a span of two or three years, a normal construction time for such a project. This is important economically, for one cannot afford to commit $10 million for very long without producing some tangible benefits.

But before the parts can be ordered and the site preparation begun, there must be a design phase. During this period decisions are made covering whether, what, and how to build, and all the foreseeable details and contingencies are put in place. In our $10 million project, the design effort might represent a mere 50 man-years, employing mostly architects and engineers (including some highly specialized ones) but also draftsmen, secretaries, and other supporting personnel—with contributions as well from various fields such as planning, market analysis, management, estimating, accounting, traffic, law, behavioral science, and computer science, and including expertise provided directly by the client's own personnel. Some of this effort is already invested in education and previous experience, but most is called into action, as in the case of the construction phase, by the project itself.

Orchestration of Design

Although design represents a small part of total project effort (say between 4 and 12 per cent), it is only slightly amenable to condensation in time and most of it has to occur before the start of construction. Its cost is a front-end load on the project, with the constant possibility of postponement, reorientation, or cancellation with consequent waste of effort. Successful orchestration and management of the design process is an art whose mastery brings important rewards.

Architecture by Team sheds important light on this art and how it may be acquired. Its author, who completed an architectural degree at M.I.T. in 1947, is a senior and founding member of C.R.S., an architectural organization which is in the forefront of innovation in building project design management.

The common lore of design professionals includes many models of design organization, some of which are repugnant. One caricature is that of the gifted artist *cum* promoter (Caudill calls him the prima donna) inside of whose shirt is stuffed a large, experienced, and practical-minded staff who manage to pull order out of chaos by successfully coping with myriad "real-world" requirements. At the other extreme is the faceless multiple partnership or corporation, none of whose members could design his way out of a paper bag but whose business acumen not only draws clients but attracts to its staff the gifted young talent who produce the real content without sharing much in the rewards.

The fact that there are real-life examples that fit such stereotypes underscores the conflict between incompatible ideas: a work of art can evolve only under the control of a single mind, but only a large group trained to work together can bring in a large project on schedule.

How To Make Players on the Team

Describing the 26-year history of C.R.S., Caudill develops a more idealistic model of team operation. The ideal team has many partners whose roles constantly shift but who work together as equals. As the team grows it is able to undertake larger tasks (and correspondingly loses its capacity to deal profitably with small ones). As time goes on new members multiply the available areas of specialization; the team spawns subsidiaries to provide geographic dispersion and more diversified services. A frequent operational ploy is to send a picked group of "squatters" to mesh with the personnel of the client group in a concentrated communication orgy to hasten decision-making.

The team contains both "idea people" and "developers" but is in principle nonhierarchical; various members "lead" insofar as their own special disciplines apply. It is self-renewing; while older members are being pensioned off, a constant search is on for recruits who can be trained to the firm's mode, and always the organization grows bigger, bigger.

The concept is admirable though perhaps less novel than the author pretends. Walter Gropius professed similar ideas in organizing The Architects Collaborative (but his own seniority and

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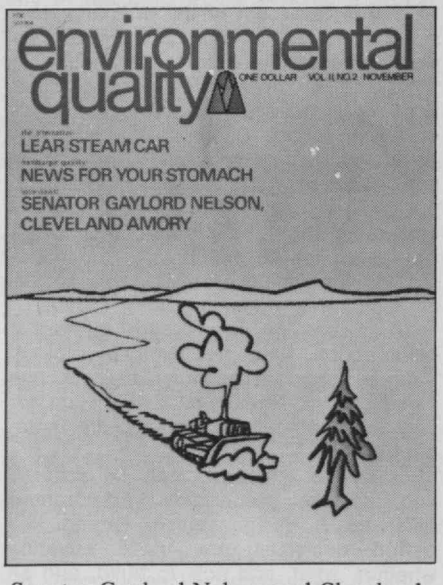
Keep Out of the Reach of Children. Cereals are healthy for TV, no so healthy for kids. A hard look at American way of breakfast, with cost and nutrient analyses of 33 breakfast foods. Other articles have examined baby foods, hamburger, water fluoridation.

Strip Mining: The Prostitution of America. And the disgrace. Richard Cramer suggests other choices.

Obscenity and Ecology. Joseph Sorrentino wonders why cops and courts go after porno peddlers with such zeal, while letting polluters sock it to society with such impunity.

Engines and Alternatives. In separate articles, we've examined the Wankel rotary engine, the Lear steam machine, the bicycle and the turbine motorcycle.

Interviews. We've talked with Walter Hickel and Henry Gibson,



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renown doubtless preserved in that venture a hierarchy disavowed by Caudill). If indeed the architect as prima donna is becoming obsolete, we are abandoning an approach sanctified in the Renaissance; we are instead returning to something more like the medieval design/construction teams, who from all we can learn were diversified and itinerant like C.R.S. personnel.

The book's most valuable insights occur in the descriptions of career development within the organization. Most of the important players on the C.R.S. team are brought forward and their roles described. One gains the picture of immature, brilliant, often rebellious newcomers gradually being shaped by their experiences and becoming valuable contributors to the team. Learning to think "we" instead of "I," it may take years for them to adapt to their colleagues, to develop their own special areas of competence, and to learn how to apply these effectively to individual projects. Clearly these are developments that must occur within the organization; they cannot be anticipated by other education or experience. Only a sustained momentum of success makes them possible.

Caudill's *Architecture by Team* is so far as I know the only attempt to deal responsibly and in detail with the human factors of managing the design process.

The Real Issues in Disarmament

Book Review:
George W. Rathjens
Professor of Political Science, M.I.T.

The Balance of Terror—A Guide to the Arms Race
Edgar M. Bottome
Beacon Press, Boston, 1972, 215 pp., $6.95; 215 pp., $2.95 paper

The Balance of Terror is an angry book by a man who believes that post-World-War-II American foreign and military policy has been misguided and worse. He has much to be angry about: our intervention abroad in support of unpopular governments, notably in Latin America and in Viet Nam; the fact that we have often seemed to apply one set of standards in rationalizing American actions during the Cold War and quite a different set to Soviet moves that are objectively similar; the efforts of the military-industrial complex, and particularly those of Secretary of Defense Laird, to sell the public on large military programs, often with arguments that have no basis in fact; and the accretion by the U.S. and the U.S.S.R. of nuclear stockpiles, and the forces to deliver them, that are so in excess of any political or military utility as to cast doubt on the rationality of our leaders and institutions.

Regrettably, Mr. Bottome's outrage appears to have exceeded his powers of scholarship. The result is a book loaded with unsupported value judgements and errors of every conceivable kind.

Many are hardly consequential to his main arguments; they simply make the book a thoroughly unreliable source of information. But as analysis Mr. Bottome's work seems equally flawed:

☐ In treating the missile-gap question he goes much too far in imputing incompetence or malfeasance to those who overestimated Soviet capabilities. In part this excess is undoubtedly a consequence of his failure to appreciate that the information available from U-2 flights was so limited that large variations in estimates of projected Soviet capabilities were not so much "unbelievable," as he says, as almost inevitable.

☐ In comparing the NATO situation in the 1970s with that of the 1950s and 1960s he correctly notes that U.S. forces in Europe have been weakened by withdrawals of men and equipment for use in Viet Nam; but he does not even mention the changed environment on the Sino-Soviet frontier and the consequent changes in Soviet force deployments.

☐ He argues that a "second-strike counterforce" doctrine is, and has been since 1962, the central motivation for U.S. strategic weapons policy. In so doing he gives no weight to the interpretation, accepted by many, that Robert McNamara's 1962 espousal of the doctrine was something of an aberration—that it was a doctrine which was forgotten almost with its enunciation, at least by McNamara and his associates at the political level, if not by all the military, to be replaced by the concept (not mentioned in Mr. Bottome's book) of "assured destruction"—the idea that U.S. force should be such that, no matter what the initiating conditions of war, we would, with assurance, be able to destroy some 25 to 30 per cent of Soviet population and most of its industrial capacity.

It is with respect to U.S. strategic weapons policy that Mr. Bottome misses his major opportunity. There are a host of questions relevant to policy that merit serious public discussion and to which a more careful analysis might have made a real contribution:

☐ What are the implications of President Nixon's explicit rejection of McNamara's "assured destruction" doctrine as inadequate? Is it a reflection of an intent to try to reestablish nuclear weapons as effective instruments of policy, and if so, where does the balance lie between risks and possible benefits?

☐ Have our weapons acquisition policies in the last several years been misguided because we have given undue weight to the danger of a successful Soviet "first strike" as compared with the other threats to our survival? (Among the latter may be listed the possibility of nuclear war being initiated accidentally, by a failure of command and control or by miscalculation; the danger of escalation; and the consequences of the proliferation of nuclear capabilities to other countries.)

☐ In our approach to strategic arms limitation has the emphasis on "bargaining chips" been misplaced? Indeed, have we not been prone to approach the whole question of strategic arms as a two-person game? Concern about equal security and relative advantage ought to be balanced with concerns that have their bases as much in the existence of the weapons themselves as in the existence of adversary nations. The larger issue is whether the perils of the balance of terror can best be reduced by negotiations with our principal adversary or by the exercise of unilateral restraint and modification of our own decision-making processes and institutions.

Mr. Bottome began his book with a quotation from Bertrand Russell: ". . . remember your humanity, and forget the rest. If you can do so, the way lies open to a new paradise; if you cannot, nothing lies before you but universal death." A sense of humanity, apparent in the book, is only one requisite. Objectivity is another, and without it and a decent regard for the facts Mr. Bottome fails to advance understanding and make "universal death" less likely. Russell was right in saying a sense of humanity is necessary; wrong in suggesting it is sufficient.

Giving Scientists Life After Death

Book Review:
Sanborn C. Brown
Professor of Physics and Associate Dean of the Graduate School, M.I.T.

The Life of Benjamin Banneker
by Silvio A. Bedini
Charles Scribner's Sons,
New York, 1972, 434 + xvii pp., $14.95

Einstein: The Life and Times
by Ronald W. Clark
The World Publishing Co.,
New York, 1971, 718 + xv pp., $15.00

Lazare Carnot, Savant
by Charles Coulston Gillispie
Princeton University Press,
Princeton, N.J., 1971, 359 + xi pp., $17.50

Selections from the Scientific Correspondence of Elihu Thomson
edited by Harold J. Abrahams and Marion B. Savin
The M.I.T. Press,
Cambridge, Massachusetts, 1971, 569 + xiv pp., $17.50

Scientific biography is an important tool in the hands of teacher and student alike, not only to emphasize the fact that scientists are very human, but also to show that the science men choose to work on is shaped to a marked degree by the forces of society around them.

Within this past year four books have appeared which illustrate in an almost classic way the different approaches used to present the lives and works of scientists to the general public.

The biography of Banneker centers on the life of a self-taught eighteenth century mathematician about whom almost nothing is recorded. The book is therefore much more a picture of the times in which Banneker lived than an interpretation of a scientist. Because he was a free black at a time when the antislavery

(Continued on p. 65)

Earl Cook
Dean of Geosciences
Texas A & M University

Energy for Millenium Three

Although it is a brief time in the evolutionary history of our planet or of the life on it, a millenium is a very long time to most people. Only a few, whose professional interests are defined in terms of time—historians, for example—can deal with 1,000 years with any sense of being relevant to the present human scene. I suspect it is a minority who consciously plan even in terms of their own adult lifetimes—say 50 years.

The public decision-maker is even more restricted in his conceptual time scale. Only a dictator can presume to visualize a "Reich of a thousand years"; the decision-maker in most modern governments has difficulty considering any problem that has not already thrust itself forcibly into the minds of his constituents, who then demand immediate solutions.

It may then seem only a pleasant intellectual excursion without practical significance to attempt to look either back or ahead on a scale of centuries at man's use of energy resources. Given the exigencies of public decision-making, this venture may be just an intellectual excursion and nothing more. But bear with me before making your judgment.

Earl Cook studied mining (B.S. 1943) and geology (M.S. 1947, Ph.D. 1954) at the University of Washington, and during this period he also studied at the Universities of Paris and Geneva. For 13 years prior to taking his present post Dr. Cook was a member of the College of Mines at the University of Idaho, and for much of this time he was Dean of the College and Director of the Idaho Bureau of Mines. Since 1964 he has been Executive Secretary of the Division of Earth Sciences of the National Academy of Sciences—National Research Council. This paper is adapted from one of the same title which he presented at the 1972 annual meeting of the Health Physics Society.

Variables in the Man-Energy System

The variables that must be dealt with in analyses of the relations of man and energy include time, the physical limits of both energy production and consumption, supply, demand, technology, cost, population, culture, and government.

Except for time and physical limits, these are not independent variables, as some of them are often treated. Demand is directly proportional to population, to cultural level, and to consumption technology; it is indirectly proportional to cost, at least as perceived by those who make resource decisions. Supply is directly related to the physical limits of the resource and of sinks for disposal of wastes; supply can be increased by technology and restricted by cost. Technology is limited by cost but expanded by the degree of inventiveness, ingenuity, and affluence inherent in a particular culture as well as by the ability of government to encourage and use it.

The relations between population, culture, government, and energy are particularly important. Population and culture are dependent on the rate of energy supply, where "culture" is taken to be the average standard of living. Government, defined as the ability to make and implement decisions designed to preserve the society and its members, is also a function of the rate of energy supply.

Historical evidence of these assumed relations of population and culture to energy supply might indicate that they have some validity.

Population and Energy Supply

Throughout most of man's history, his population has increased as his control and consumption of energy has increased. In other words, population growth has taken place in surges that reflect leaps in man's increasing control of energy.

An illustration is afforded by the history of China during the past 1,000 years. During this millenium each sharp rise in Chinese population can be nicely correlated either with extensive cultivation of a new or improved food plant or with intensive use of fertilizer and increased use of fossil fuels; each peak in population can be correlated with saturation of the land area adaptable to the new crop, and each subsequent decline in population can be correlated with declining agricultural production brought about by overplanting, soil depletion, erosion, flooding, and subsequent civil war or invasion.

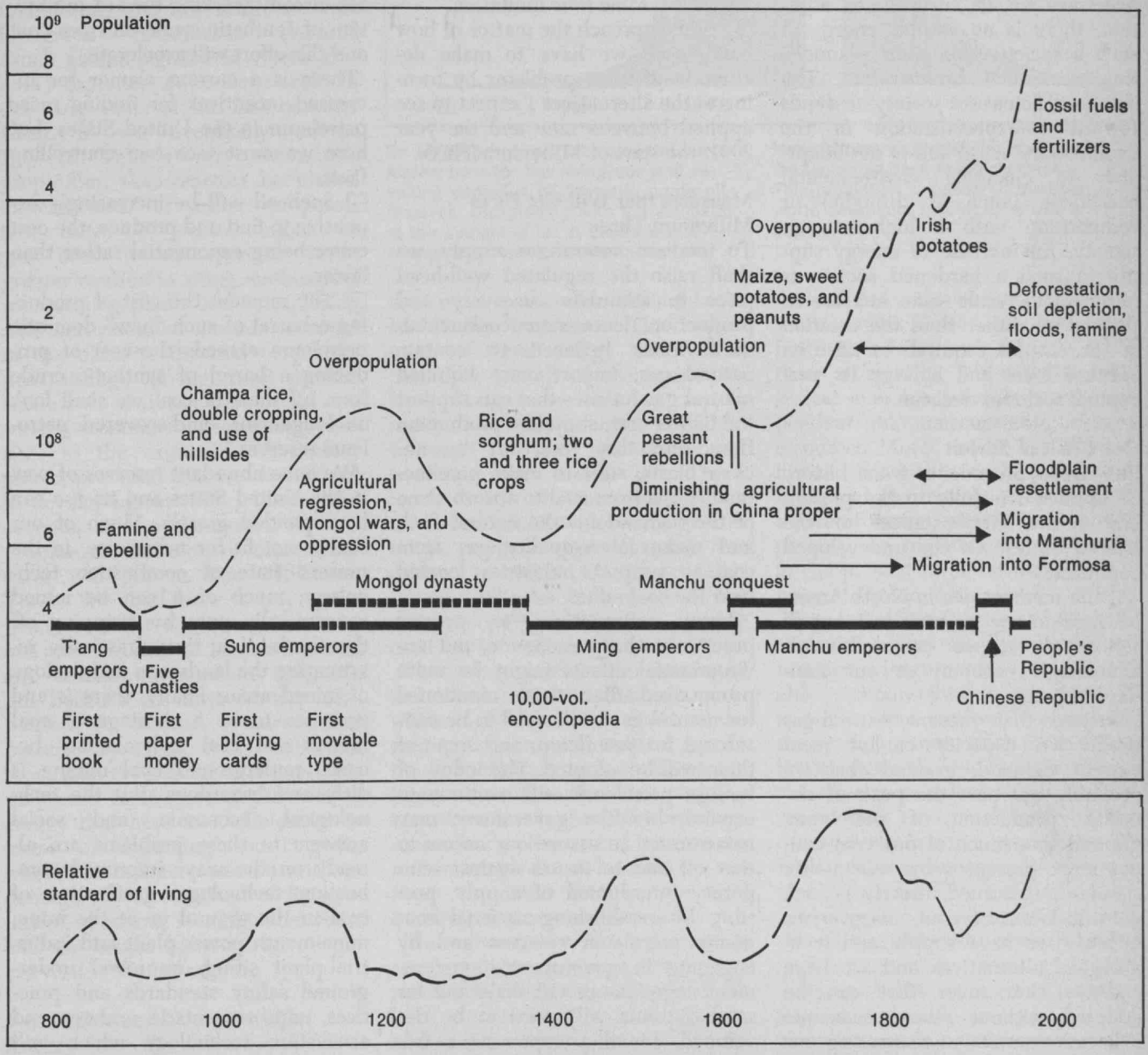
Government and Energy Supply

That the stability of governments is a function of energy supply is also shown by the Chinese history, wherein each major decline in energy supply has been accompanied by a change of dynasty or form of government.

This correlation is perhaps more than merely coincidental. The ability of government to make and implement decisions calculated to preserve a society is a function of the energy supply to that society.

In a primitive agricultural society where the energy supply is barely sufficient for the subsistence of its members, government in the decision-ability sense is replaced by attitudes, mores, and conventions which have the force of law and which direct behavior along set lines; it is very difficult for an individual or a group of individuals to effect change in such a society,

Beyond 2100, mankind's energy needs must be met by a combination of coal, nuclear power, and solar energy—beyond 2300, by technologies that are not yet known to be possible, much less economical.



China's history demonstrates the interrelationship of energy and culture (expressed here as standard of living). The introduction of new food plants allowed cultivation of previously unusable land; new varieties of rice allowed double-cropping and planting on land above flood plains; maize and sweet potatoes could be planted on mountain sides, and the Irish potato on mountain tops. In each case, energy supply increased. But erosion, soil depletion, flooding and famine were inevitable, as was, apparently, a change in government, when the energy supply receded.

There is little doubt that humanity will overshoot the ability of existing energy sources to sustain it. It faces drastic reduction of its population by pestilence, starvation, and warfare, unless technology can save it.

even if that change appears to them necessary for its survival. In addition, there is no surplus energy in such a society to support planners, thinkers, and administrators. The energy-deficient society tends toward overspecialization in the evolutionary sense and is not adaptable to changing environmental conditions (such as drought) or competition with a higher-energy society. An increase of energy supply to such a hardened society is most apt to result in an increase in population rather than the creation of the surplus required to raise its cultural level and enlarge its perceptual scale for decision.

Our Crisis of Surfeit

Can these precedents from history be applied fruitfully to the present and future circumstances of the United States? Of the undeveloped countries?

At the moment, we in North America face no energy crisis in terms of serious threats to our industrial-technologic economy or our standard of living.

Granted that present natural-gas productive capacity cannot meet current demand, granted that we probably are past the peak of domestic production of petroleum, granted that much of our coal cannot meet present urban air-quality standards if burned directly as fuel, we still do not have an energy *crisis*, because we have supply and technological alternatives and we have end-use alternatives that can be adopted without severe economic dislocations, without decreasing our material standard of living, and without serious threat to our national security. On the other hand, because we are dependent on nonrenewable resources which have finite quantity limits, the statement above must have some *time* limitation.

Let me approach the matter of how much time we have to make decisions and solve problems by turning to the alternatives I expect to see applied between now and the year 2001, the start of Millenium Three.

Measures that Will Get Us to Millenium Three

To increase *natural-gas* supply, we shall raise the regulated well-head price to stimulate discovery and production; lease more continental-shelf tracts believed to contain natural gas; import more liquified natural gas for uses that can support the higher cost; stimulate production from refractory reservoirs by nuclear blasts; start to make pipeline-quality gas from coal to absorb some of the demand for the natural fuel; and make lower-quality gas from coal to support industries located near the coal mines.

Certain alternatives to present practice (whose economic and environmental effects might be more pronounced than those mentioned for natural gas) will need to be considered for *petroleum*, and some of them will be adopted. The inflow of foreign petroleum will continue to expand, but the government may move to try to assure our access to that oil and to insure against temporary interdiction of supply, possibly by establishing national economic petroleum reserves and by engaging in government-to-government negotiations. Oil shale and tar sand deposits will need to be developed, for they represent a tremendous energy reserve available to the United States and Canada which may allow us some time to adjust to the fact that we have depleted our natural heritage of petroleum faster than anyone else on earth. We are already working toward production of synthetic crude oil from coal and this effort will accelerate.

There is a current clamor for increased incentives for finding more petroleum in the United States, but here we must face two controlling facts:

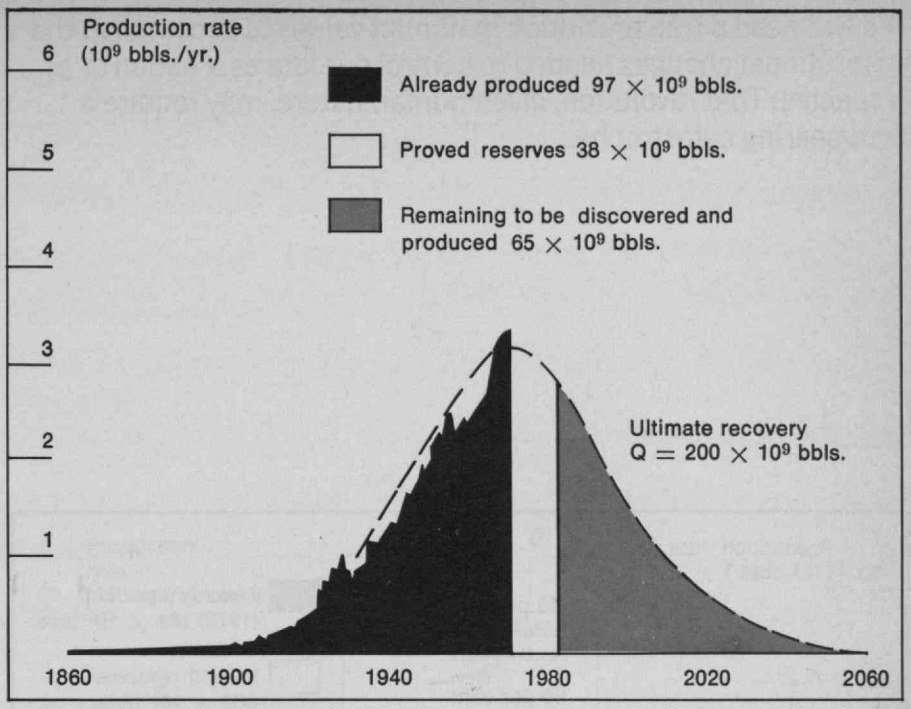
☐ Such oil will be increasingly expensive to find and produce, the cost curve being exponential rather than linear.

☐ The moment the cost of producing a barrel of such "new" domestic petroleum exceeds the cost of producing a barrel of synthetic crude from oil shale or coal we shall look no longer for "undiscovered petroleum reserves."

We have abundant reserves of *coal* in the United States and its use can be expanded greatly. Much of our coal is not fit for urban use, in the present state of combustion technology; much of it can be mined economically only by stripping off the overburden, thus drastically rearranging the landscape and ecology of mined areas; finally, there is and promises to be a shortage of coal miners and coal technologists, because underground coal mining is dirty and hazardous. But the technological, economic, and social answers to these problems are already on the way: improved combustion technology, gasification of coal in the ground or at the mine; mine-mouth power plant and industrial-plant siting, improved underground safety standards and practices, improvements in underground excavation technology which will make underground mining a more attractive economic alternative to surface stripping, and innovative preplanned land reclamation in stripped areas.

Although there is considerable controversy over the appropriate figures, it appears almost certain that before the year 2000 there will be a shortage of low-cost *uranium* to fuel a greatly expanded nuclear-power industry based on present reactor technology, which is extremely inefficient in its utilization of the energy content of natural uranium. Even the development of practical breeder reactors will not avert this shortage because they will require substantial amounts of uranium to build fuel inventories to efficient operating levels. On the other hand, a successful breeder reactor technology will render the fuel cost almost immaterial, and we shall see vast low-grade uraniferous deposits (such as the lignites in North Dakota) exploited on a large scale in the early years of the 21st century. Even if we eventually accept Edward Teller's very reasonable proposition that reactors be placed underground, or other proposals that they be located afloat, at sea; even if we exercise vastly greater caution in siting nuclear-fuel reprocessing plants and in exploring sites and potential hazards involved in the ultimate disposal or permanent storage of high-level nuclear wastes; we shall not have raised any serious economic or technologic barriers to the expansion of nuclear power, provided that we do succeed in developing an efficient, safe, and economical breeder reactor.

Some combination of these measures will get us into Millenium Three. We shall have to pay somewhat more for the energy we use, not only in order to keep our urban and coastal environments tolerable but because we have strong competitors for foreign resources and because synthetic fuels will cost more than the natural ones have. We may even limit some of our uses of energy that have low efficiencies in terms of achieving social goals, which we certainly can do without damage to our standard of living—unless, of course, 10-million-car years and the bright lights of Las Vegas are vital to that standard.



Dr. M. King Hubbert proposes the curve shown here for the rising use and resulting depletion of domestic crude oil reserves. Disagreeing with the estimates of the amount of oil available would change the area under the curve but leave almost unaltered the reality, and the timing, of the coming shortage. This projection is based on ultimate world petroleum resources of 200 x 10^3 barrels.

Renewable and Nonrenewable Energy

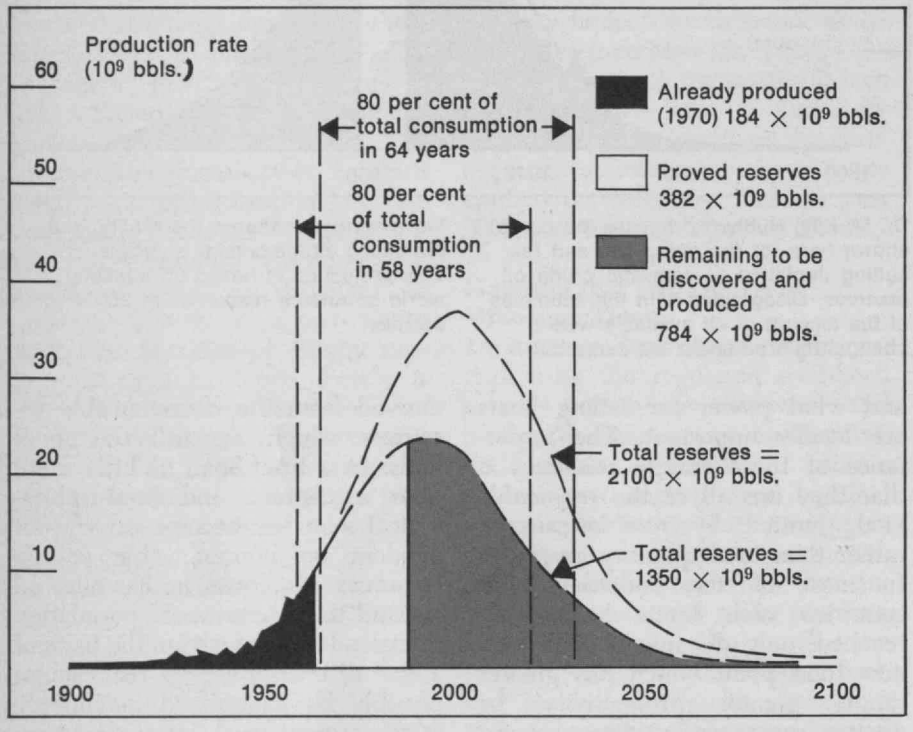
The energy used in the underdeveloped countries today comes mainly from plants and animals: food and wood, dung, and animal power. Water power for irrigation and wind power for sailing boats are locally important. The importance of these energy resources is that they are all of the *renewable* kind, limited by *rate of supply* rather than total quantity available. In most of the underdeveloped countries such limits have been reached; only the introduction of a new food plant which has greater range, greater productivity, or greater resistance to disease occasionally provides an increase in the energy supply, an increase quickly used up by new mouths to feed.

The energy used in the developed and overdeveloped countries is overwhelmingly from the fossil fuels: coal, petroleum, and natural gas. In the U.S., 98.7 per cent of the energy input comes from these sources. The important fact is that this sort of resource has no theoretical limit on the *rate* at which it can be used up but there is a finite limit on the total *quantity* that can ever be used.

Throughout most of his history as an identifiable species, man relied on renewable energy resources for food, heat, protection from other animals, and to power boats, drive mills, lift water, and pull plows. Only about 150 years ago did he start, on a significant scale, to switch over from wood and wind, from animals and falling water, to heat and power derived from the nonrenewable resources which we call the fossil fuels. In a brief span of little more than a century, industrial-technological man has become utterly dependent on nonrenewable energy resources. Moreover, he has allowed his and the whole world population to expand enormously on the basis of a *rate of energy supply* that cannot possibly be maintained indefinitely at the present level, let alone an exponentially increasing level.

Population is a function of the rate of useful energy supply, whether or not that energy comes from renewable or nonrenewable resources. If it comes from renewable resources, the rate cannot rise more than briefly above the rate of renewal and therefore populations dependent on renewable resources tend rather quickly to become stabilized in ecological equilibrium with the rate of supply. Our China example does not disprove this general theorem; the relative instability of the Chinese population arose from a human tendency to overgraze and to overharvest renewable resources so that they become depleted, and from the availability of new land to be exploited; the amplitude of the instability was limited by the renewability of food resources (whence came China's famed "bounce-back" capa-

We will need a true revolution in human values to accomplish the institutional changes needed to control our fate as a nation or as a species. That revolution, given human nature, may require a soul-searing catastrophe.



The curves represent two estimates of world consumption of the earth's crude oil reserves, using two estimates of the total amount available. But in both cases, severe world shortage is predictable at not very different points in the future.

bility).

A population based on nonrenewable resources, on the other hand, faces a much more formidable instability problem. Its rate of usable energy supply depends not on man's efficiency in extracting energy from a dynamic system constantly being renewed but upon the rate he *chooses* to extract energy from a static system that is not renewable on any time scale meaningful to him. The more he allows his numbers to become dependent on this self-chosen rate, the more he faces ultimate catastrophe, which can be delayed only by finding new sources of nonrenewable energy (represented by an efficient breeder reactor, for example) and which can be averted only by finding new sources of renewable energy large enough and renewable fast enough to sustain his vastly increased numbers.

The Real Crisis: Replacing the Mined-Energy Economy

Although we began so short a time ago to devour them, the ultimate exhaustion of the fossil fuels can be foreseen clearly. Dr. M. King Hubbert's depletion-history curves for petroleum suggest that domestic supplies will not be used as fuel beyond the year 2000, when it will be about 90 per cent exhausted, and world crude will not be available beyond about 2025, when it will have reached a comparable state of depletion. After those years, and perhaps well before them, petroleum will have become too valuable as a new material in the production of synthetic protein and other products for it to be burned as fuel. Natural gas will last no longer than petroleum.

A cumulative production curve of the Hubbert type reveals how little difference in the useful life of a resource a wide difference in reserve estimates makes. Two estimates for total recoverable oil are shown on his world crude-oil curve; the higher estimate exceeds the lower by 55 per cent, yet the time until 90 per cent depletion is thus advanced by only 11 years! Whether or not one agrees with the areas under Dr. Hubbert's cumulative production curves, the ephemeral nature of the fossil fuels is apparent. Depletion is a physical reality, not just a controversial tax allowance.

There is some evidence that the symmetry of the Hubbert curves will be altered somewhat by history, but not in a way that gives hope of greater production. Both the cumulative production curve for Lake Superior hematite iron ore (now essentially exhausted) and the computer-calculated depletion curves published in *The Limits to Growth* show steeper descents than ascents.

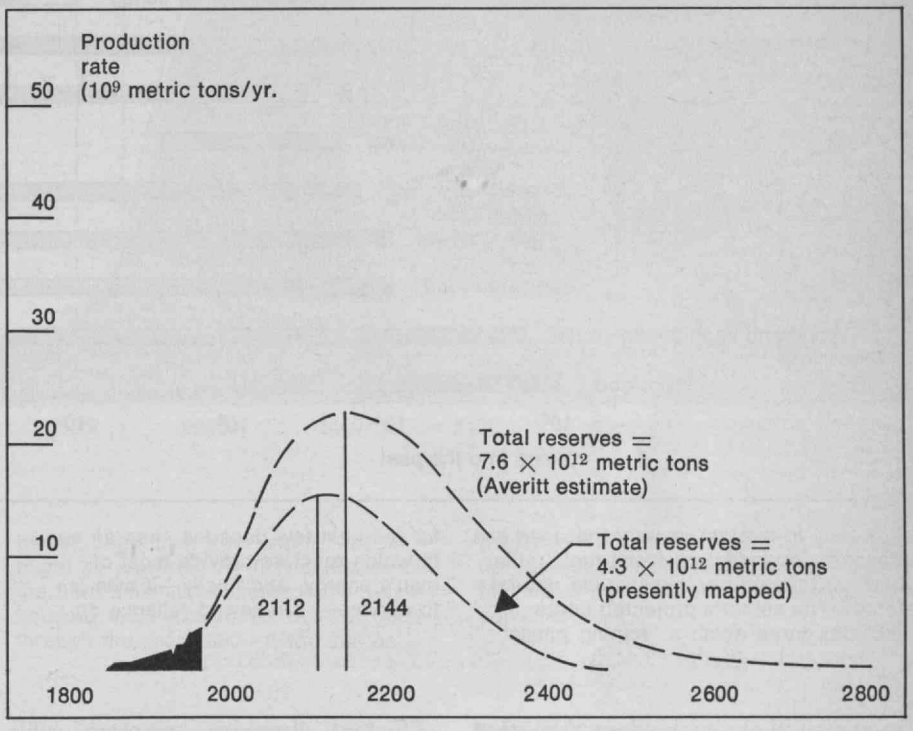
The world picture for coal is not nearly so bad; world use of coal as an energy source will not reach its peak until sometime in the 22nd century.

With present nuclear technology, the uranium "fuel" for atomic power will be exhausted in about 100 years, but with efficient breeders it will be extended an order of magnitude or more. It should be emphasized that

this 100-year estimate is for a complete production and technological cycle. Both the Atomic Energy Commission and the Bureau of Mines have pointed out that proven low-cost reserves, domestic and foreign, are not sufficient to supply the anticipated domestic demand to the end of this century. Thus if large new reserves of uranium are not found, or if efficient breeder reactors are not developed, the nuclear power industry will die a lingering death, with its decline becoming evident before the year 2000.

There is little doubt that the human population has greatly overshot the ability of existing energy resources based on present technology to sustain it very far into Millenium III, and that it faces drastic reduction of its numbers by starvation, pestilence, and warfare unless the technologic cavalry come riding over the hill in the nick of time.

The fact—which we are only beginning to confront—is now clear: the probability of finding, or creating by technology, new reserves of nonrenewable energy resources is diminishing. The exploitation of a technological breakthrough such as the fast breeder, which breaks out of the short-term fuel constraint, will be limited by environmental factors. We must plan, and hope, to replace our mined-energy economy; and while we continue to seek adequate replacement systems through scientific and technological effort, we need to consider reducing both our appetites and our numbers in case technology simply presents no alternatives. And we should remember that for millions of starved and starving people in the world, it is already too late.



The situation for the world's coal is not as disturbing as is the situation for oil. We can have a few centuries' use of coal yet, but only at environmental expense. Coal is not very pleasant to mine or to burn. On the basis of presently known resources, we will reach the half-way point in coal consumption in 2112; on the basis of total reserves as estimated by Averitt, in 2144.

Renewable Sources

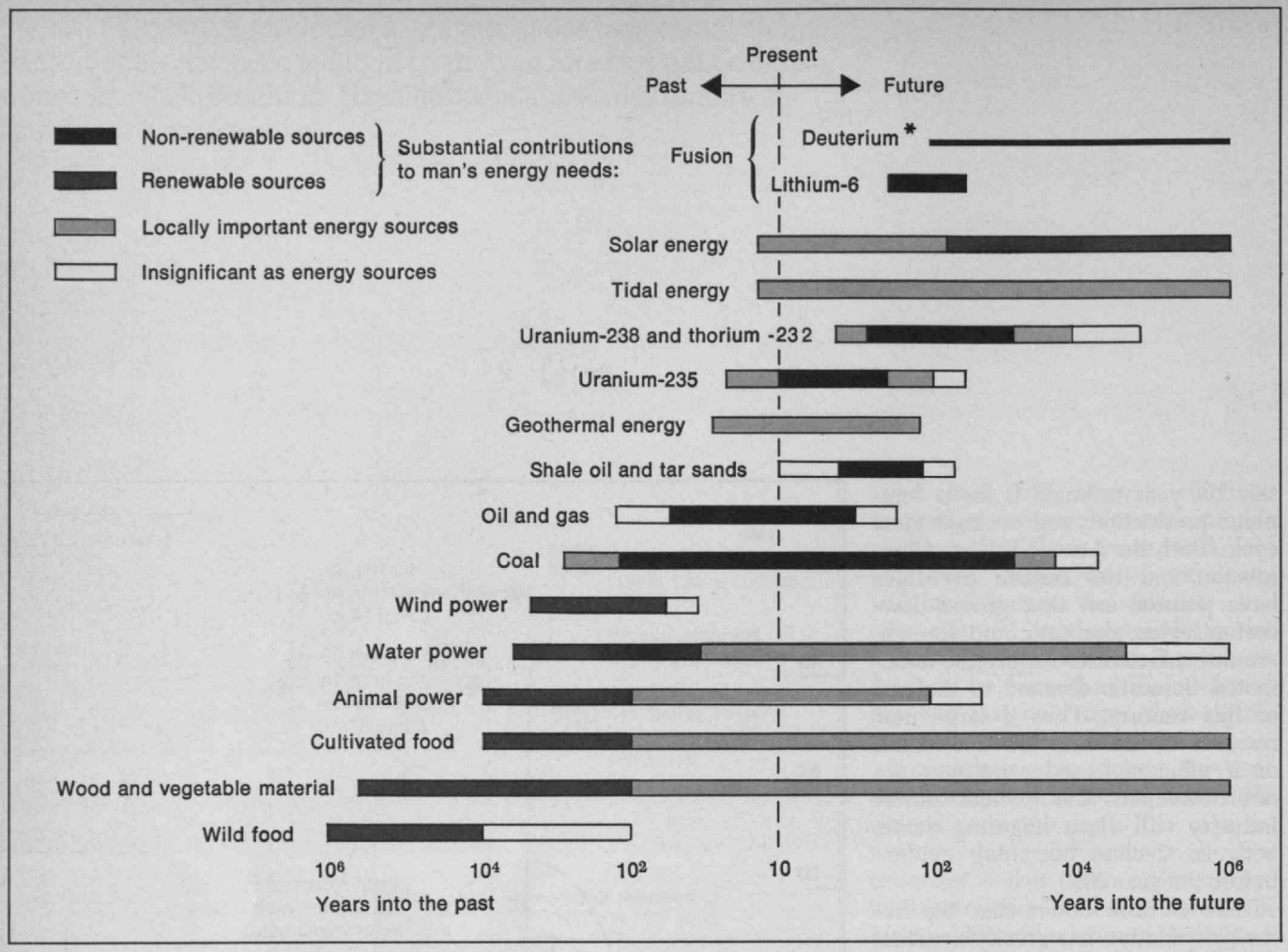
Perfection of the advanced-breeder reactor may give us time to adjust to the inevitable. But the breeder is not the final answer, for its proliferation will be limited by ecological imperatives related to heat effluent and radioactive wastes.

Man must ultimately return to renewable sources of energy.

Unless fusion power based on the consumption of deuterium alone (and not lithium-6) becomes practicable, the only renewable source of energy large enough to support man will be solar radiation, and solar-power technology may turn out to require so much capital investment that the cost of the power produced will limit the quantity used, so that it will be insufficient to support several billion people.

The Impact of Cost on Energy Consumption

The future of energy consumption, and man himself, depends primarily on the real cost of usable energy or power. The cost of fossil-fuel power is escalating as reserves diminish, the requirements of environmental protection increase, and new conversion devices become necessary. The cost of nuclear power by present technology likewise is increasing. The real cost of power from efficient breeder reactors, a matter of considerable debate at present, now



It is only in the last century that man has become dependent on fossil fuels rather than on tapping non-exhaustible natural forces. The author's projected future includes three ages: a "mining phase" for the next few decades, then an age in which reactors provide most of man's energy, and finally—if man is to survive— a renewed reliance on natural forces rather than exhaustible fuels—a "solar phase." *Deuterium will be a renewable source only if technology can make it so.

seems unlikely to be less than that from present sources.

The total cost of power production, will be the ultimate constraint on man's use of energy. If all relevant costs were to be included in the price of energy, the brake would be applied immediately, and we might have a fair hope of reaching a stable plateau of energy use. If, on the other hand, ecological and social costs are not included in energy pricing, and growth in power use continues to be subsidized and encouraged as it now is, the man-energy-environment system will grow less and less stable and will collapse catastrophically.

A Sequence of Constraints

Oil and natural gas, declining fast in the year 2000, will be replaced by a mix of synthetic fuels (from coal, tar sands and oil shale) and nuclear power.

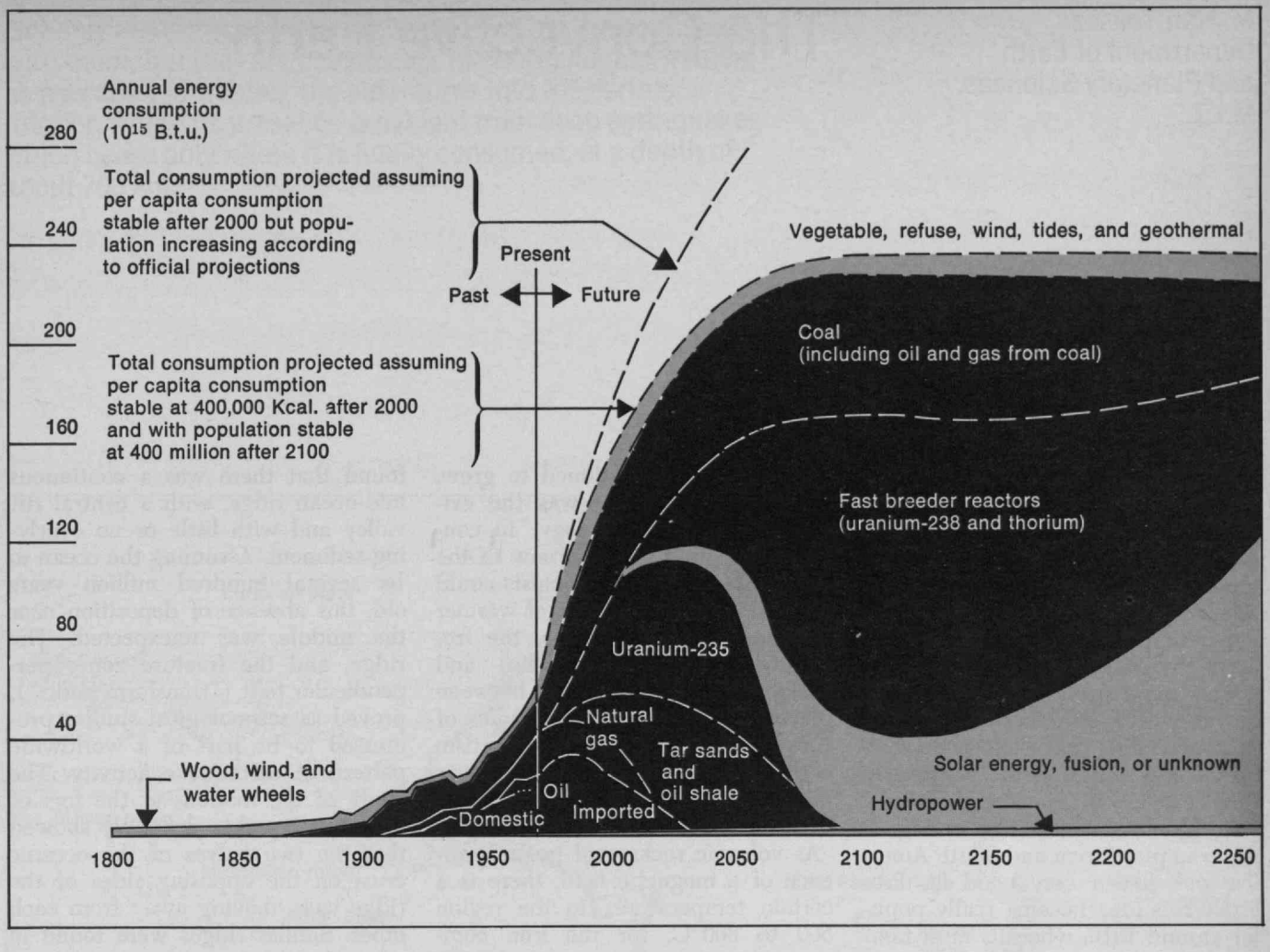
Efficient breeder reactors will come on line none too soon, because they will have to take up the slack as the tar sands, oil shale, and uranium-235 begin to play out.

Because the rate of energy derived from coal will be limited by environmental and economic factors and the rate from breeder power plants by environmental factors, some new and major source will have to be found, if the human population is to be maintained at anywhere near the levels projected for the next 100 years. The sources which technological man hopes to make use of on a large scale are fusion power and solar energy. Energy derived from vegetable material and refuse, from tidal and other water dams, from wind power, and from geothermal traps will be important locally, but not to the world community.

Beyond the year 2100, it seems clear that U.S. and world energy needs must be met by a combination of coal, nuclear power, and solar energy; beyond 2300, by nuclear and solar energy, mainly by the use of technologies not yet known to be feasible, let alone economic.

The future of man's use of energy seems divisible into three phases, each marked by the dominance of a particular type of constraint on energy use:

Duration (years)	
$n10^1$	The *mining* phase—lasting another few decades for petroleum and natural gas; a century for oil shales, tar sands, and fissile uranium; and a few centuries for coal—in which resource availability is the dominant constraint.
$n10^2$	The *rock-burning* phase, lasting perhaps a few hundred years; in which the dominant technology is that of the



What does the future hold for U.S. energy consumption—and the sources whence it comes? This proposal projects consumption under two different population conditions—and shows for a stabilized population how energy needs might be met into the first centuries of the third millenium. Energy will surely become more expensive, but—at least through the year 2250—it will still be available. This stable-population assumption produces a plateau of about four times the present rate of energy consumption.

breeder reactor, the primary fuels are fertile uranium and thorium, and the dominant constraint is environmental quality, principally waste-management limits.

$10^{x>2}$ The *solar* phase, which could last until man or the sun fades out; where the dominant constraint will be the cost of power in relation to its benefits.

Fusion power may or may not enter this scheme; if it does, it will fall into the first phase (mining) if it requires lithium, between the second and third phases (rock-burning and solar) if deuterium only.

An orderly transition from one of these phases to the succeeding one, given the technologic feasibility, would seem to require some direction by man, since it has been demonstrated that the economic system currently employed by the greatest consumers of energy tends neither to perpetuate a finite common resource nor to provide for its replacement by an equivalent or greater good.

Whether or not we shall continue to rely on faith in technology, or Providence, to save us from the consequences of our profligate use of non-renewable resources I don't care to predict. It seems to me that right now we should start to use such resources more efficiently and more conservatively. But that is much easier said than done, given the powerful forces in our institutions that encourage material growth and consumption. We shall need a true revolution in human values to accomplish the institutional changes needed to control our fate as a nation or as a species; and that revolution may require a catastrophe as damaging and soul-searing as the potato famine in mid-19th-century Ireland.

Suggested Reading

"Energy Technology to the year 2000", published by *Technology Review*, Cambridge, Mass., 1971.

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The Convective Earth

The idea that the earth's continents were once a single land-mass, from which they broke away and have been drifting apart, has had a checkered history. Two generations ago it was very popular, the next generation rejected it, and now today's geophysicists have reinstated it in a more subtle form within the new research field known as "seafloor spreading and plate tectonics."

From the shapes of the continents, it is natural to imagine that they once fitted together, edge to edge—for example, Africa and South America look like a very good fit. Precisely this idea became really popular around 1910, when its most famous proponent was Wegener. Wegener's idea was that the continents were somewhat lighter than the material below—now known as the mantle—and that the mantle, though dense, was relatively fluid. The continents were thus floating on the mantle, like sheets of ice on water. This idea was obviously very attractive, but later on it was discovered that the material below the continents was not in fact fluid, but generally rigid. In the 1930s and 1940s, since no one could see how the continents could move, Wegener's idea was more or less abandoned.

But the evidence suggesting that the continents had moved during their history, and originally were joined together, continued to grow. For one thing, there was the evidence of paleoclimatology: in continental regions that are now in the high, cold latitudes, geologists could see deposits characteristic of warmer climates. There were, too, the frequent geological similarities and rock-age correspondences between places separated by large bodies of water. Then came paleomagnetism—the determination of the intensity and direction of the earth's magnetic field in former times.

As volcanic rocks cool in the presence of a magnetic field, there is a certain temperature (in the region 500 to 800°C. for the iron compounds commonly present) known as the Curie point, at which they acquire a permanent magnetization. This provides a record of the local magnetic field at the time when the rock was formed. There is a similar effect in sedimentary rocks—as they are deposited, the small grains of magnetite in them tend to orient themselves in the direction of the earth's magnetic field. So the earth has a magnetic memory: if one knows the age of formation of a particular stratum, one can (with specially designed equipment) measure the local direction of the earth's magnetic field at that date in the past. In the early 1950s, when this kind of work expanded, it was soon discovered that the "fossil magnetisms" were not aligning with the present magnetic field. Either the earth's magnetic field must itself have changed direction, or the earth's crust must have moved relative to the magnetic poles.

The Earthquake Pattern

During that time another line of attack opened up: the extensive study of the oceans. In the Atlantic, it was found that there was a continuous mid-ocean ridge, with a central rift valley and with little or no overlying sediment. Assuming the ocean to be several hundred million years old, this absence of deposition near the middle was unexpected. The ridge, and the fracture zones perpendicular to it ("transform faults"), proved as seismological studies progressed to be part of a worldwide pattern of earthquake activity. The study of the motions at the foci of these earthquakes definitely showed that the two halves of the oceanic crust on the opposing sides of the ridge were moving away from each other. Similar ridges were found in other oceans.

Seismology has in recent years made enormous advances in scope and precision, thanks to the deployment of a large number of highly sensitive detectors, including seismic arrays, which can pinpoint the sources of very small disturbances. The arrays employ radio telemetry and computers in such a way as to constitute, in effect, a kind of acoustic telescope, constantly watching the interior of the planet.

Earthquakes are the best evidence of the dynamic nature of the earth's crust and upper mantle. As shown in the accompanying map, earthquakes are distributed mainly along certain relatively narrow belts. One belt runs around the Pacific—Japan, the Aleutians, the North American West Coast, the South American Andes. Another, very narrow, belt coincides with the Mid-Atlantic ridge. Furthermore, the same coincidence of earthquake activity and mid-oceanic ridge can be seen in the East Pacific Rise, and in the Indian Ocean (whose "earthquake ridge" extends into the Red Sea).

Earthquake activity is not the same

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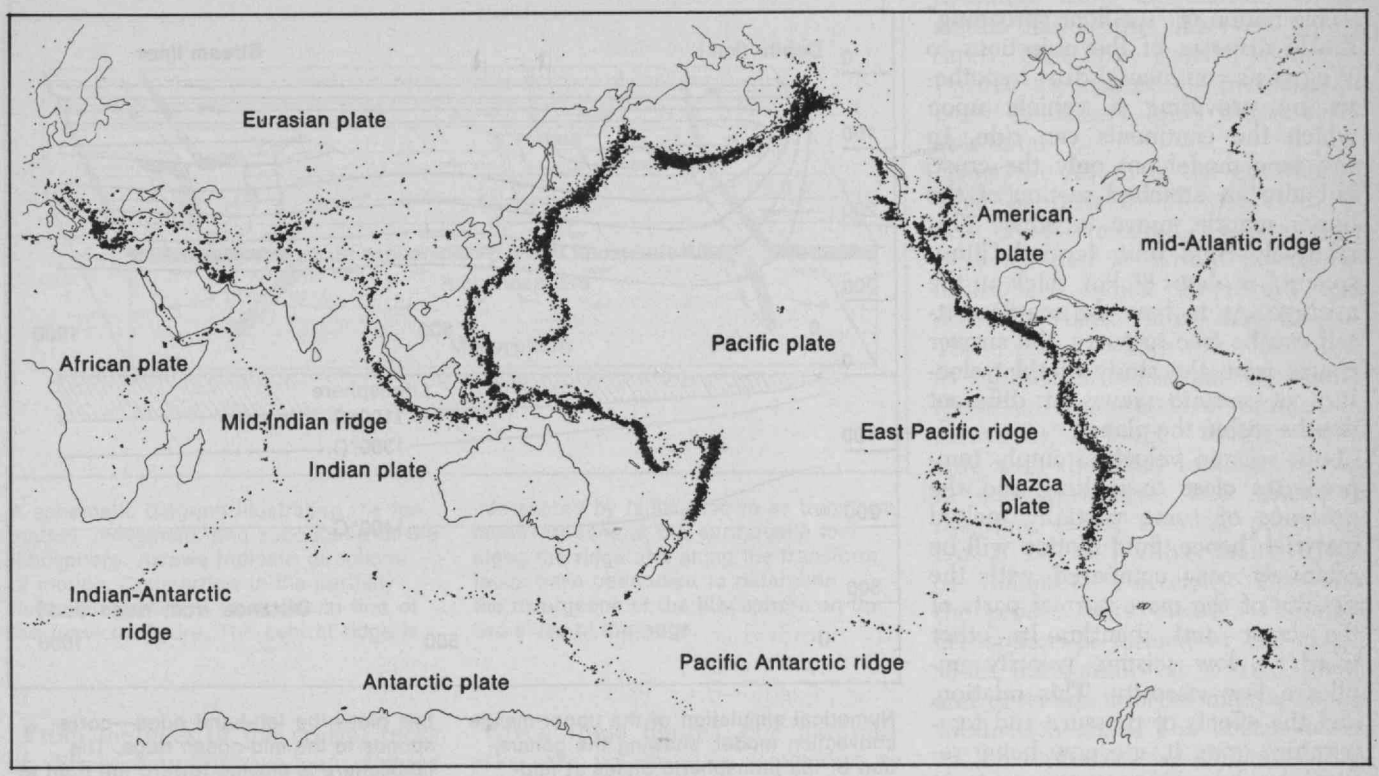
Not only are the ocean floors moving, carrying the continents with them, but they are in a process of continual reformation; as new crust is created, the old returns into the earth's interior, where its presence is evident from deep earthquakes which cease only where it is finally consumed, at a depth of about 700 km.



Distribution of earthquake epicenters for the period 1961-1967. The oceanic ridges and the marginal "subduction zones" (where, respectively, plate material rises and sinks) are clearly outlined. Major plates and ridges are identified by name. Note the greater abundance of earthquakes at the subduction zones, on the continental sides of trenches.

in the different active belts. There are apparently two kinds of quake zones, one corresponding with mid-ocean ridges, and the other with the "trenches" found along some oceanic boundaries. In the former, the quake activity is less intense and quite close to the surface. In the latter the earthquake activity is much more intense and extends much deeper into the earth's mantle. The significance of the latter type will be discussed later in much greater detail.

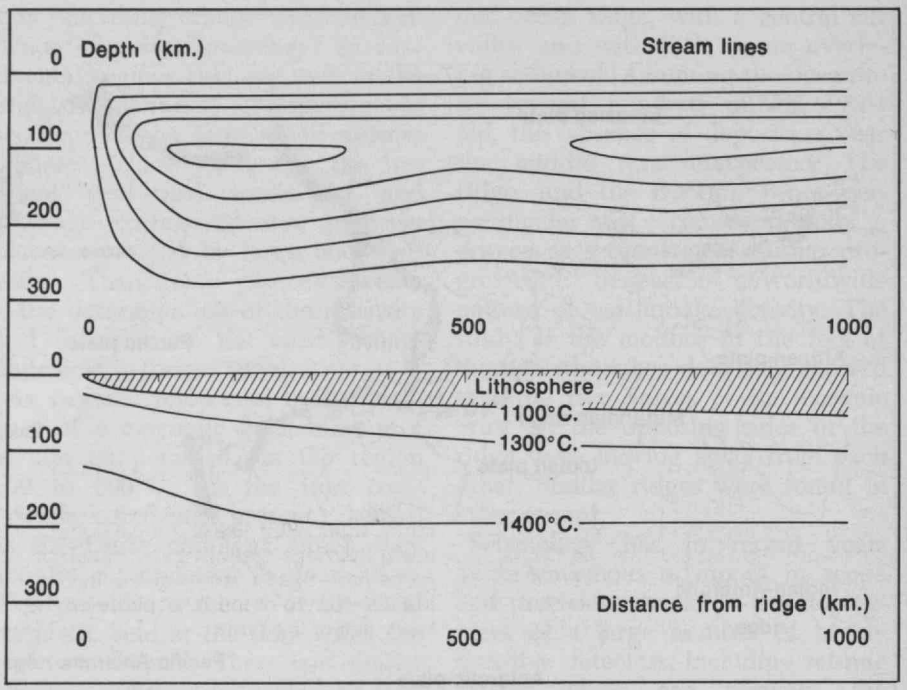
Perhaps the most dynamic piece of evidence came from extending the paleomagnetism principle to the ocean bottoms. Rock-magnetism researchers had observed that during its history the earth's magnetic field has reversed itself many times—the north pole abruptly becomes the south pole, and vice versa (quite apart from the gradual changes that suggest that the continents have drifted relative to the poles). Magnetic surveys across the Atlantic Ocean, made from the surface, turned up a pattern of alternating disturbances of the earth's (present) magnetic field—increased magnetic intensity and decreased magnetic intensity, by turns—as the recording vessel scanned the ocean along an east-west line. The beauty of this survey was that it recorded a symmetry about the mid-ocean ridge.

Combining this magnetic record with other age-dating methods, it became clear that as one moved farther and farther from the ridge axis, the rocks of the ocean floor got older —not the sediment, but the igneous floor itself. So the sea floor was being continuously created at the ridge, and from there it was pushed outward to make room for new crust; like a pair of diverging conveyor belts. Thus, the Atlantic bottom turns out to be about 200 million years old at the edges and quite new in the middle.

This notion of "sea-floor spreading" neatly disposes of the objections to Wegener's continental drift hypothesis by providing a vehicle upon which the continents can ride. In this new model not only the crust, but also an attached section of the upper mantle, move together. This relatively rigid unit, termed "lithosphere," is about 80 km. thick on the average. As to how the sea-floor itself can be free to move, the answer comes from the study of the velocities of seismic waves at different depths within the planet.

Low seismic velocities imply temperatures close to melting and the presence of some partially melted material; hence, fluid motion will be relatively easy compared with the rigidity of the more normal parts of the crust and mantle. In other words, a low seismic velocity implies a low viscosity. This relation, and the effects of pressure and temperature upon it, are now being refined by laboratory experiments in which rock samples are brought to great pressures—by both static and explosive means—to simulate conditions down to thousands of kilometers depth.

If one plots the seismic velocity and viscosity as a function of depth, one finds an outer crustal layer about 10 km. thick under the oceans and 40 km. thick under the continents. Below this there is a high-viscosity, rigid region, and next a zone where viscosity drops by several orders of magnitude, below which it increases again. The low-viscosity layer is an ideal medium for decoupling the "conveyor belt" which we call the lithosphere from the mantle. Between 100 km. and 300 or 400 km. depth there is sufficient fluidity for thermal convection; convection is required as a driving force for the observed horizontal motion.



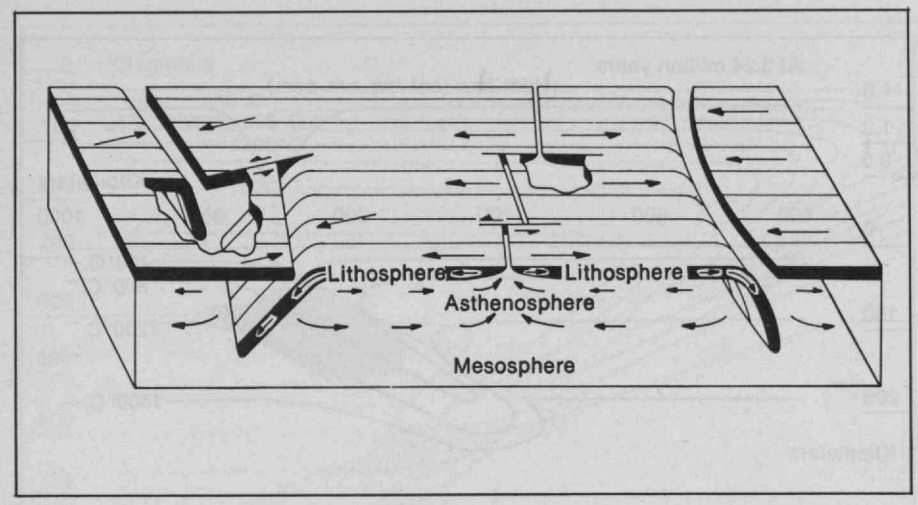
Numerical simulation of the upper-mantle convection model, showing the generation of the lithospheric plates at mid-ocean ridges. The upper half of the diagram shows the stream lines, the lower half shows the isotherms. The origin of this plot—the left-hand edge—corresponds to the mid-ocean ridge. The lithosphere is moving toward the right at a velocity of 1.2 cm./year, and grows thicker as it moves away from the ridge.

The Earth's Heat-Engine

But this manner of reviving the idea of continental drift raises a host of new questions, the main one being: if a new crust is being formed, what becomes of the old one? The earth is not (one can calculate) expanding, so one must conclude that the old crust is somehow being consumed. And thus it proves to be—the evidence for it coming from the above-mentioned recent advances in seismology and earthquake studies. I shall return later to this question and the current answers to it, but first let us look at the moving lithosphere in a little more detail.

The rigid lithosphere is somewhere between 50 and 100 km. thick—in most places, about 80 km. As I have said, the earth's properties, as deduced from the velocities of sound waves, change with depth. At about 100-150 km. depth there is a zone called the asthenosphere, where the material is partly molten—perhaps one per cent is liquid and the rest solid—and where some degree of convective circulation can take place. The new crust is formed where the convective current is upward, forcing some material to the surface to replace the crust.

It is becoming feasible to compute the workings of the whole subcrustal heat-engine, and thus to explain quantitatively the dynamics of continental motion



A schematic diagram illustrating the formation, movement, and subduction of the lithosphere. Arrows indicate directions of motion. Counterflow in the partially fluid asthenosphere is similar to that of the previous figure. The central ridge is intersected by faults, known as transform faults. Motions at the earthquake foci along the ridge and along the transform faults have been used to determine the divergence of the lithosphere on the two sides of the ridge.

From the ages of the crustal rocks at different points, we can deduce the spreading velocities: somewhere between one and ten centimeters per year. So any two points on diverging plates will be moving away from each other at perhaps as much as 20 centimeters per year, which in 10 or 20 years should add up to a distance that could be measured with some precision. There has been a very concentrated effort, using both ground-based observations and satellites, to see whether the Atlantic Ocean really is getting wider. Before the end of this decade, some truly convincing data will emerge from these studies. In other areas, as for instance along the San Andreas Fault, we find two plates in relative motion along a common edge. It is an irregular motion, but the average rate is about two centimeters a year.

Given these figures, one naturally asks: are we then in a position to compute the workings of the whole subcrustal heat-engine, using reasonable estimates of the subterranean temperature differences that drive it? And this kind of calculation is indeed becoming feasible. The diagram on this page is the computer-generated result of a series of computations by Dr. D. J. Andrews here at M.I.T. It shows in a fairly realistic way the formation of the crustal lithosphere from rising hot fluid, the progressive thickening of this layer to about 80 km., and the convection flow patterns. This is a model for the Atlantic Ocean and it generates quite a reasonable version of the mid-Atlantic Ridge topography tapering off to the sides.

So we are now able to say not only that we can observe continental motion but also that we can explain its dynamics using calculations whose results match the observed topography, heat flow, gravity anomalies (which are observable measures of crust thickness), and other available data.

Now, we return to the question of what happens to the old crust as new crust is created. There is now evidence that at certain places the lithosphere bends downward and descends back into the mantle. These places, which are referred to as subduction zones, can be clearly identified from modern seismic observations, and they roughly coincide with the deep trenches known to oceanographers. The schematic diagram, taken from a paper by Drs. B. Isacks, J. Oliver and L. Sykes of Columbia University illustrates the process very clearly. The new lithosphere is formed at the ridge, slides horizontally as a rigid plate, and descends into the mantle at the subduction zone. The ocean ridges are characterized by shallow earthquakes. Rigid plates are generally aseismic. Both shallow and deep earthquakes occur near the trenches. The large earthquakes such as the Alaskan earthquake of 1964 and the Chilean earthquake of 1960 are results of the shallow thrusting of the oceanic plates under the more stable continental plates. The deeper earthquakes occur near the trenches, but are very much deeper than the trenches themselves.

In South America, Japan, and the Aleutians, for example, the foci of the deep quakes have been plotted in three dimensions; they prove to lie in a plane, inclined toward the continent. What we are seeing is a solid crustal plate, sliding down into the mantle at an angle of 30° to 65° to the horizontal, and remaining quite rigid to 700 km. down.

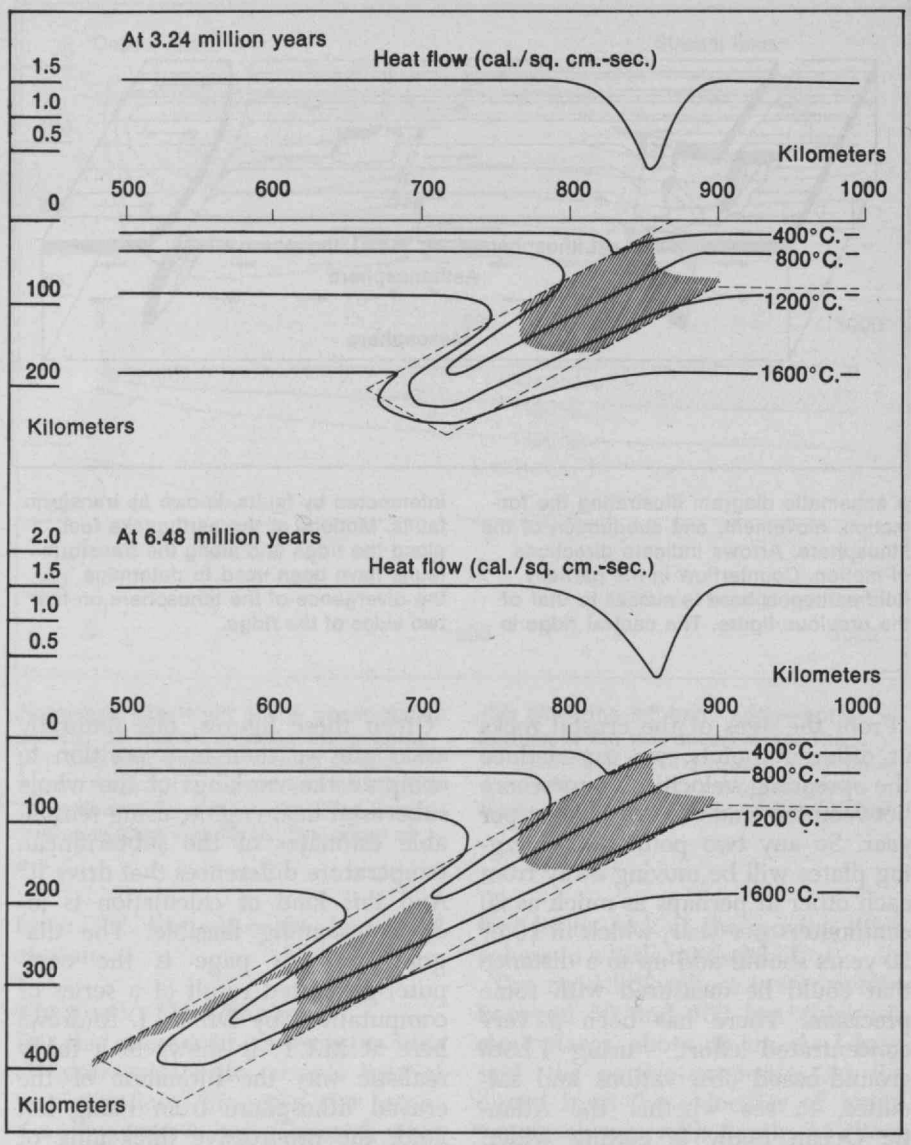
And indeed, the question arises as to why the earthquakes invariably stop at 700 km. depth—given the sizes of the crustal plates.

Computing the Downward Motion

The most probable answer, I think, is that as the material descends into a progressively warmer medium, it gradually heats up and loses its identity and becomes assimilated into the mantle. The quakes are symptoms of stress concentrations in rigid materials, and thus will occur only where the descending lithosphere is cool and rigid. Deep earthquakes are associated with the cooler interior parts of the downward moving slabs. It is not clear whether the descending plate is being impelled downward by the convection of the asthenosphere under it, or whether it is simply sinking under its own weight. The temperature and consequent density differences must play an extremely important role in this driving mechanism.

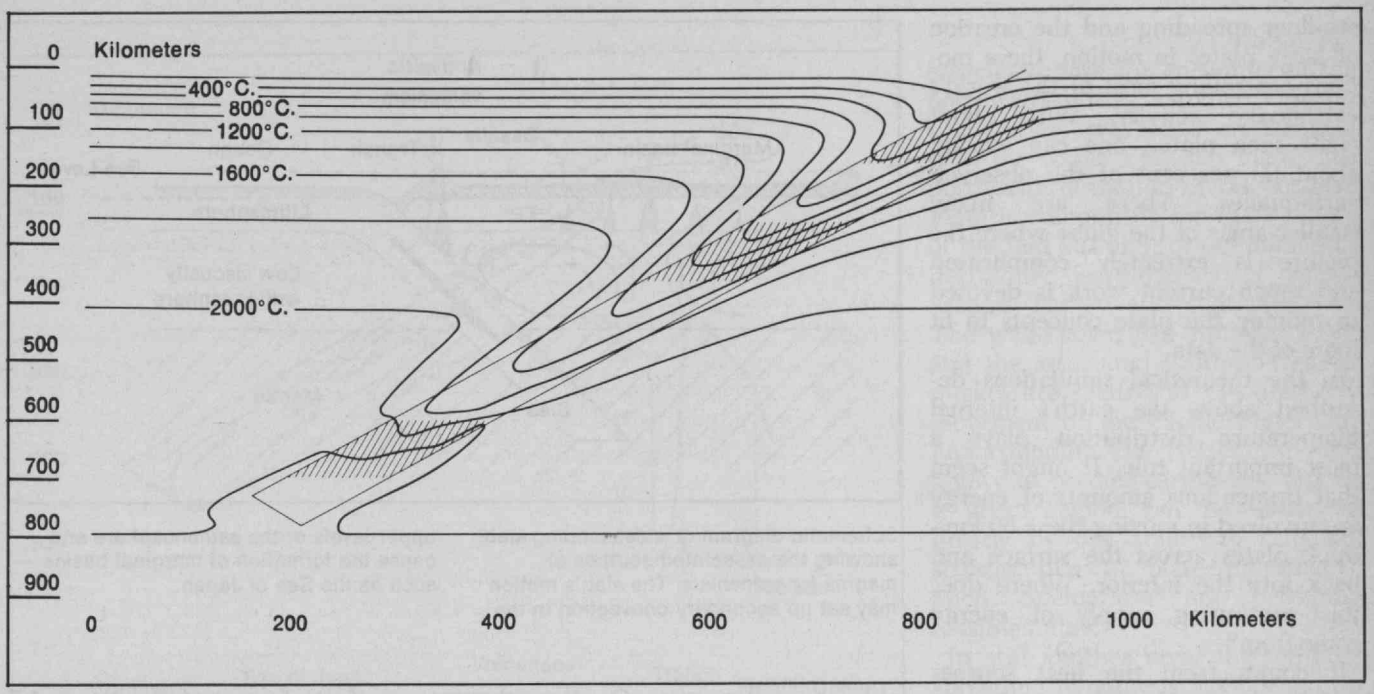
To quantize these thoughts, it is important to compute the conduction of heat into the moving slab, which can be done on the basis of the probable ambient temperatures at different depths and the thermal conductivity of the rock. The results of such an extensive calculation are shown in the accompanying diagrams. The thermal conductivity of most of the earth's materials is low. Thus heat is conducted in very slowly and for a long time the center of the slab remains cool. Six million years after the leading edge begins the descent, the center is still cool, but parts of the slab have undergone phase transformations (which complicate the calculations).

A time comes, however, when a number of changes occur, at about



The thermal evolution of a descending lithospheric slab is shown in diagrams on this and the opposite page. It moves at a velocity of 8 cm./year, corresponding to the rates under Japan and Tonga. The gradual heating at 3.24, 6.48, and (right) 12 million years is visible. At a depth of 700 km. the slab reaches thermal equilibrium with the surrounding mantle, and is being consumed. Shaded regions indicate transformation of the material to denser phases. The curves above show the surface heat flux over the subduction zone.

Under Japan, the earthquake hypocenters outline a slab, tilting down from the edge of the ocean. In the nearby shallow ocean areas, the type and distribution of quakes suggest the bending and sliding of a plate which is fairly rigid and elastic . . .



600 km. depth. The descending rock undergoes a phase transition which releases heat; independently, as temperatures rise, radiative heat transfer becomes more efficient, increasing the rate at which heat is conducted into the slab, and by the time the slab reaches a depth of 700 or 800 km. its temperature is that of the surrounding environment (in fact, it might even be higher), so that it is more or less assimilated into the mantle.

In the marginal basins between a trench and a continent, volcanism is observed. A secondary sea floor-spreading phenomenon may be associated with downward movement of the slab, as shown in the diagram on page 30. Japan and the Japanese Sea are, respectively, the best examples of island-arc volcanism and marginal basins. In island-arc volcanoes, as one goes further away from the trench, one finds some evidence that the magma comes from deeper and deeper regions. This is expected from our models.

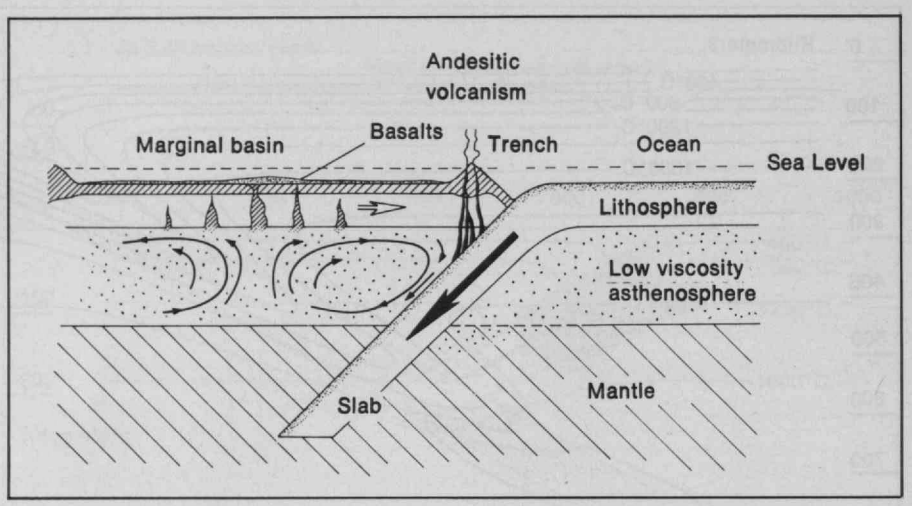
So in the past few years we have learned not only how new material could arise to form a lithosphere and the sea basins, but also how the surplus lithosphere could re-enter the earth's mantle and be assimilated back into it. Significant evidence that these ideas correspond to reality comes from seismic records, as I have indicated. The temperature regimes specified in the model are verified by seismic velocity measurements, among other things. Also, the distribution of earthquake occurrences matches the hypothetical movements of the lithosphere. Under Japan, for example, we find the picture shown on page 31. The quake hypocenters outline a slab, tilting down from the edge of the ocean.

In the shallow areas near the ocean trench we find a fairly large number of earthquakes, whose type and distribution suggest the bending and sliding of a plate which is fairly rigid and elastic, so that stresses can be released only by rupture. It is these sudden ruptures that are manifested as earthquakes. We see that these earthquakes continue down to about 600 km. The deeper earthquakes (below 100 km.) can be correlated with the calculated stress distribution (obtained by converting the temperatures into density differences and computing the resulting gravitational imbalances). This correlation holds not only for earthquake locations but also for the directions of the released stresses.

This, then, is a brief summary of the evidence that leads most contemporary geophysicists to accept the new ideas that are grouped under the heading of plate tectonics:

sea-floor spreading and the creation of large plates in motion, these motions controlling most of the world's earthquake activity. With about eight such plates, one can explain about 90 per cent of the observed earthquakes. There are many smaller areas of the globe where the picture is extremely complicated and much current work is devoted to refining the plate concepts to fit more of the data.

In the theoretical simulations described above the earth's internal temperature distribution plays a most important role. It might seem that tremendous amounts of energy are involved in moving these 80-km.-thick plates across the surface and back into the interior. Where does this continuing supply of energy come from?



Schematic diagram of a descending slab, showing the associated sources of magma for volcanism. The slab's motion may set up secondary convection in the upper levels of the asthenosphere and cause the formation of marginal basins such as the Sea of Japan.

It comes from the heat sources within the earth. The earth was heated very early in its history, it is thought, by accumulating the gravitational potential energy of the accreting particles from which it formed. More importantly, the earth contains radioactive heat sources—uranium-238, uranium-235, thorium-232 and potassium-40 are the most common of them—which have long half-lives and thus continue to be fairly efficient heat generators. Given this heat supply and some degree of fluidity, convective circulation between the hot interior and the cooled surface seems, intuitively, almost inevitable.

The net heat flux from the inside of the earth toward the surface is 66 ergs per square centimeter per second, which works out to be 10^{28} ergs per year over the whole surface. When one computes the total energy of all earthquakes, it works out to be about 10^{25} ergs per year —a very small fraction of the available thermal energy. On the other hand, the latter is itself small compared to the energy that the earth receives from the sun. But this solar supply is mostly radiated back into space and has little influence except in the atmosphere.

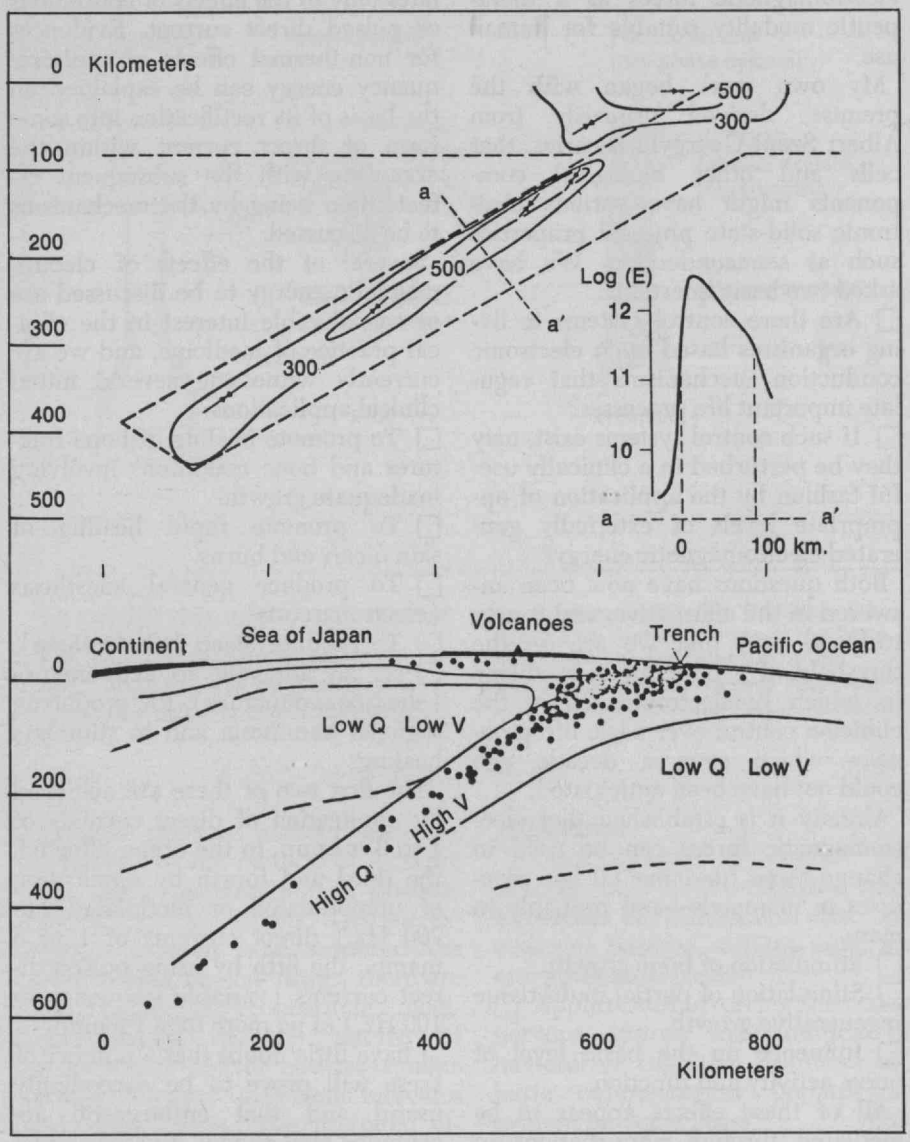
Moon and Mars

In this context one might ask whether there are corresponding tectonic processes in some of the other planetary bodies. But even in the case of Mars, on which we have much new data, the answer is that we really do not know: at this stage we may recognize a volcanic caldera, but we cannot tell whether it is 10 million years old or 1 billion years old. The moon, thanks to the Apollo flights, we know very much better. What we see on the Moon is quite interesting. The Moon went through the type of evolution I have described more than three billion years ago; it was active from the time of its formation to about 1.5 billion years later, by which time it had lost most of its internal energy.

The earth, in contrast, is at the peak of its evolution: on the geological time-scale, the Atlantic is a recent innovation. The difference can be explained fairly simply on the basis of relative sizes. And since Mars falls about half way between the earth and the Moon in regard to size, we would expect that planet to be less active than the earth. It might have passed through most of its evolution some time ago, but there would still be some residual activity—it will not be as dormant as the Moon is today.

Earth Applications and Resources

The understanding of the lithospheric plate motions has many visible and practical consequences, in addition to its scientific significance. The rise of the Himalayas, the world's tallest mountain range, is



Cross-section of calculated stress model (upper) and the distribution of earthquakes (lower) in descending lithosphere under Japan. The units of stress are "bars" (very closely, atmospheric pressures). Inset diagram indicates the Young's modulus variation inside the slab due to temperature effects. Arrows point the direction of maximum principal stress. In the lower diagram earthquake foci are indicated by black dots. The shallow quakes are located along the boundary between the descending lithosphere and the stable lithosphere. Deep quakes are located along the interior of the slab where the slab is coolest and where calculated stresses are maximum. Low Q (high attenuation of seismic waves) and Low V (low velocity) indicate the asthenosphere.

associated with the encounter of the northward-moving Indian peninsula—which was once an island—with the stable Eurasian Plate. The northeasterly motion of the Arabian Plate is responsible for the opening of the Red Sea and for the numerous destructive earthquakes of southeastern Turkey and southern Iran. The well-known San Andreas Fault and the associated California earthquakes are related to the northerly movement of the Pacific Plate. Our understanding of seismicity and ability to predict earthquake risk in a given region can be enhanced greatly by our ability to calculate stresses due to plate movements. Such calculations are becoming feasible today.

In still another area, the sea-floor spreading hypothesis has opened up new vistas in petroleum and mineral exploration. From the reconstruction of continents as they were in past geologic times, knowing the time of formation of a given deposit it may be possible to find an originally neighboring deposit which is now a part of a different continent. Such reconstruction can point to promising regions that are yet unexplored.

These examples of how the basic scientific understanding of sea-floor spreading and plate tectonics can be directed into applications from earthquake prediction to exploration for petroleum and mineral resources, significant as they are, are only the beginnings of a new era in the geological sciences.

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Electromagnetic Forces and Life Processes

The concept that electromagnetic forces might have any effect upon living organisms—other than the thermal effect due to Joule heating—was for many years rejected by the organized biomedical community. But under the weight of experimental evidence this attitude is changing; indeed, the medical community is now expressing considerable interest in the possible therapeutic effects of direct application of small amounts of electrical energy. Within the past year reports of clinically useful effects have appeared in the scientific and the popular press. Thus the arguments over the electrical nature of life processes, which extend back at least to the work of Luigi Galvani, the Italian physician who wrote on "animal electricity" in 1791, are reaching a new and very promising resolution.

My own laboratory began working in this area in 1958, and the response to our reports has changed from complete rejection just over a decade ago through amused disbelief to—at present—enthusiastic acceptance. I believe the field has now reached a stage of understanding where it is important to assess the present stage of knowledge, the implications of that knowledge, and—especially—the possible dangers in premature acceptance of electromagnetic forces as a therapeutic modality suitable for human use.

My own work began with the premise, derived primarily from Albert Szent-Györgyi's theories, that cells and other biological components might have various electronic solid-state physical properties such as semiconduction. We have asked two basic questions:

☐ Are there control systems in living organisms based upon electronic conduction mechanisms that regulate important life processes?

☐ If such control systems exist, may they be perturbed in a clinically useful fashion by the application of appropriate levels of externally generated electromagnetic energy?

Both questions have now been answered in the affirmative, and it may truly be said that we are on the threshold of a new era in medicine in which bioelectronics offers the clinician control over basic life processes which even a decade ago could not have been anticipated.

Already it is established that electromagnetic forces can be used to change three fundamental life processes in mammals—and probably in man:

☐ Stimulation of bone growth.

☐ Stimulation of partial multi-tissue regenerative growth.

☐ Influence on the basic level of nerve activity and function.

All of these effects appear to be mediated through perturbations in naturally pre-existing electronic control systems. All are produced by low levels of direct current (continuous or pulsed) administered directly to the organism. At this time there appears to be a power-density relationship centered at an extremely low power level.

The discussion which follows relates only to the effects of continuous or pulsed direct current. Evidences for non-thermal effects of radiofrequency energy can be explained on the basis of its rectification into some form of direct current within the organism, with the subsequent effects then being by the mechanisms to be discussed.

Several of the effects of electromagnetic energy to be discussed are of considerable interest in the clinical practice of medicine, and we are currently witnessing several initial clinical applications:

☐ To promote healing of bone fractures and bone conditions involving inadequate growth.

☐ To promote rapid healing of skin ulcers and burns.

☐ To produce general anesthesis (electronarcosis).

☐ To produce sleep (electrosleep).

☐ As an adjuvant to acupuncture (electroacupuncture), for producing regional anesthesia and to stimulate healing.

The first two of these are achieved by application of direct currents of 1 to 3 mμamp. to the organ affected, the third and fourth by application of unmodulated or modulated (to 700 Hz.) direct currents of 1 to 5 mamp., the fifth by using pulsed direct currents (variable frequency to 100 Hz.) of no more than 1 mamp.

I have little doubt that a number of these will prove to be exceedingly useful and that enthusiastic acceptance will follow. But one must understand that, despite its pretentions to the contrary, medicine is not a science but an art founded in empiricism—a random search for tools that produce a desired effect on the patient. The history of medicine reveals enthusiastic acceptance of almost all treatment modalities

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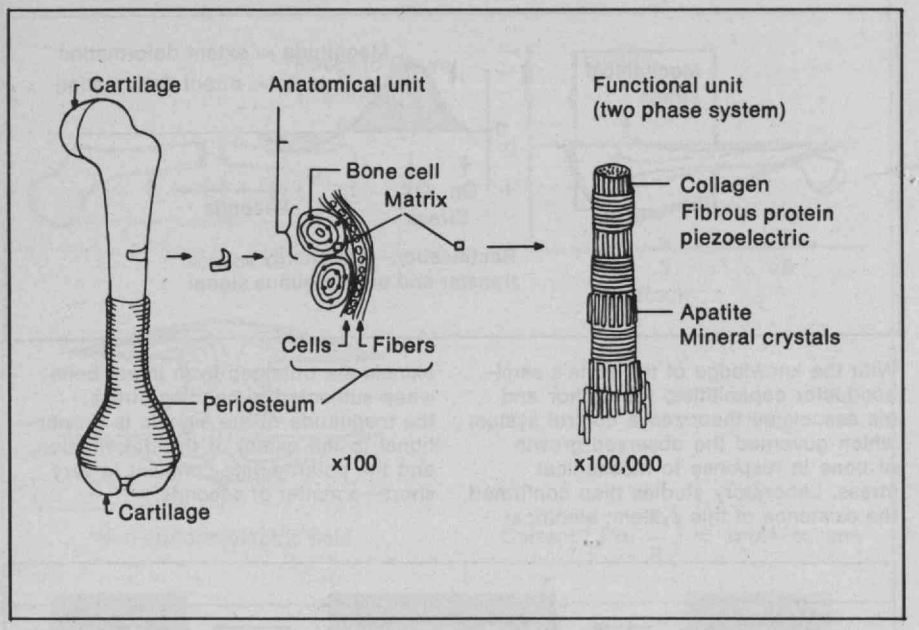
Dr. Robert O. Becker received his medical training at New York University (M.D., 1948) and joined the Veterans Administration Hospital at Syracuse in 1957 as Chief of the Orthopedic Section. He has recently given up administrative responsibilities as Associate Chief of Staff for Research to devote full time to developing the work reported in this article, a field in which he has published extensively; but he continues to serve as Research Professor of Orthopedic Surgery at the Upstate Medical Center of the State University of New York. This paper is the substance of a report by Dr. Becker at the 1972 convention of the I.E.E.E.

New research has made clear the role of minute electrical currents and voltages in controlling the development of animal structures and the healing of wounds. Detailed understanding of the life systems involved may be the next great advance in biomedical science.



The author's (and others') studies reveal that bone does in fact display solid-state electrical properties, and that these properties are associated with living bone cells—a small percentage of the total bone material. Collagen, the associated fibrous protein in the bone cell matrix, is piezoelectric; it and apatite, the mineral crystals associated with collagen, are both semiconductors.

that are effective without any consideration of the method of working and little consideration of possible deleterious side effects. Though extensive controls now surround the introduction of new drugs, there are few regulations concerning medical devices of the nature of those which deliver electromagnetic forces. Present evidence indicates that such forces have profound effects through the perturbations they induce in the naturally occurring electronic control systems within living organisms, and indeed that in this work we are gaining access to biological control systems of a very basic nature. Several very real dangers are inherent in the premature widespread clinical use of these techniques:

☐ Unrecognized deleterious side effects—such as malignant transformation of cells—may exist, and may not become evident until several years have passed.

☐ Applications involving the central nervous system may induce behavioral or cognitive disorders of a basic nature—again, perhaps not evident for some years.

☐ In the desire for immediate clinical rewards, extremely important applications may be overlooked.

☐ Acceptance of this technique as clinically useful may—without proper regulation—bring forth hordes of charlatans and quacks purveying ineffective but costly "treatment devices."

I believe that the situation is serious, and I urge that, as a first step, a working union should be organized between clinicians, biomedical workers, electronic engineers, electrochemists, and solid-state physicists to help achieve understanding of the uses and dangers of application of low-level electromagnetic forces. I doubt if such a basic question as how such forces influence biological systems can be answered without the multidisciplinary approach I propose.

The "Current of Injury"

The work in my laboratory in investigating this field has been chiefly on the role of small electromagnetic forces in cellular growth and regeneration. We began by studying what is called the "current of injury"—an electrical potential which always appears at a site of injury in a living organism. We measured this "current of injury" in two closely related animal species, one of which could regenerate a limb and one of which could not. (Most readers will be aware that certain animals—salamanders, for example—can regrow an amputated limb; this occurs by a particular growth process characterized by the appearance of a mass of primitive cells, forming themselves gradually into a complete multi-tissue extremity appropriately organized.) We found very specific differences in the "current of injury" which were postulated to be related to the two different processes involved in regeneration and nonregenerative healing.

Professor Marcus Singer had previously reported on a direct relationship between the extent of innervation to a limb—its integration into the nervous system—and the ability of the animal to regenerate

that appendage after amputation. We therefore next investigated the relationship of the nervous system to this phenomenon, and we found that nerves (or their closely related supporting tissues) generated longitudinal electrical potentials which appeared to have their origin in semiconducting properties of some element of the nerve itself. After several years of studying this phenomenon, we developed the thesis that this property was organized into a primitive data transmission and control system that dealt with such modalities as the receipt of pain sensations (indicative of an injury) and the control of subsequent repair processes (to insure that they were appropriate and adequate).

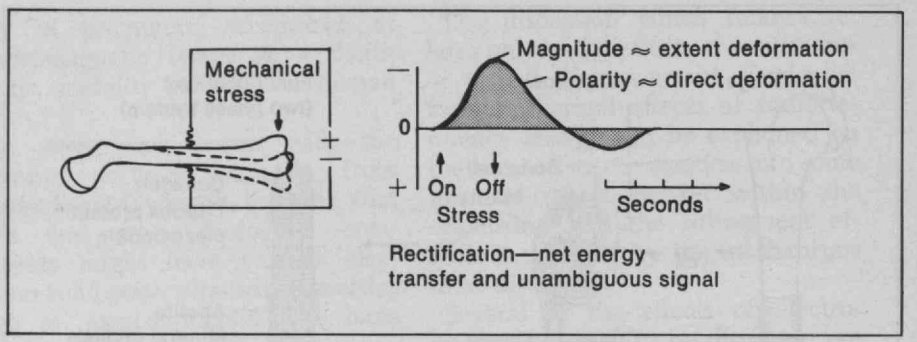
The neural electronic system also seemed to be related to levels of consciousness and biological cycles, and we have developed the thesis that this system furnishes the linkage mechanism between electromagnetic forces in the environment and biological cyclic behavior. Thus we may for the first time have a basis for understanding such interesting, generally accepted phenomena as these:

☐ Reversals of earth's magnetic field are related to the extinctions of various animal species.

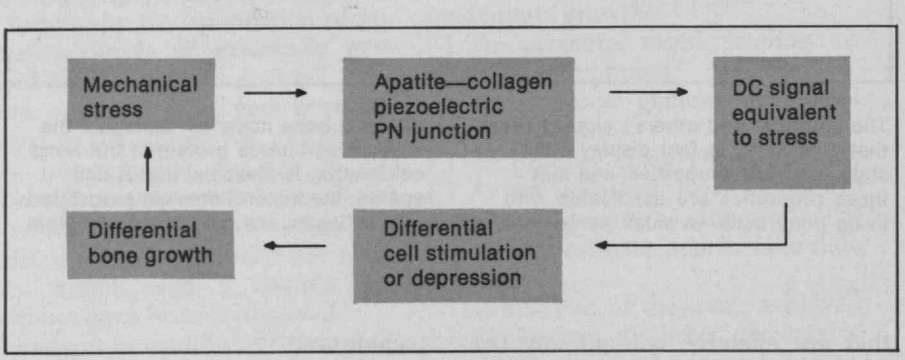
☐ Cyclic patterns in the earth's field are related, perhaps causally, to biological cycles.

☐ Disturbances in the earth's field (magnetic storms, etc.) are statistically related to behavior disturbances in the human population.

☐ There is a direct link between the earth's magnetic field and the migratory and homing activity of animals and birds.



With the knowledge of the bone's semiconductor capabilities, the author and his associates theorized a control system which governed the observed growth of bone in response to mechanical stress. Laboratory studies then confirmed the existence of this system; electrical signals are obtained from intact bone when subjected to bending stress; the magnitude of the signals is proportional to the extent of the deformation, and the polarity time-constant is very short—a matter of seconds.



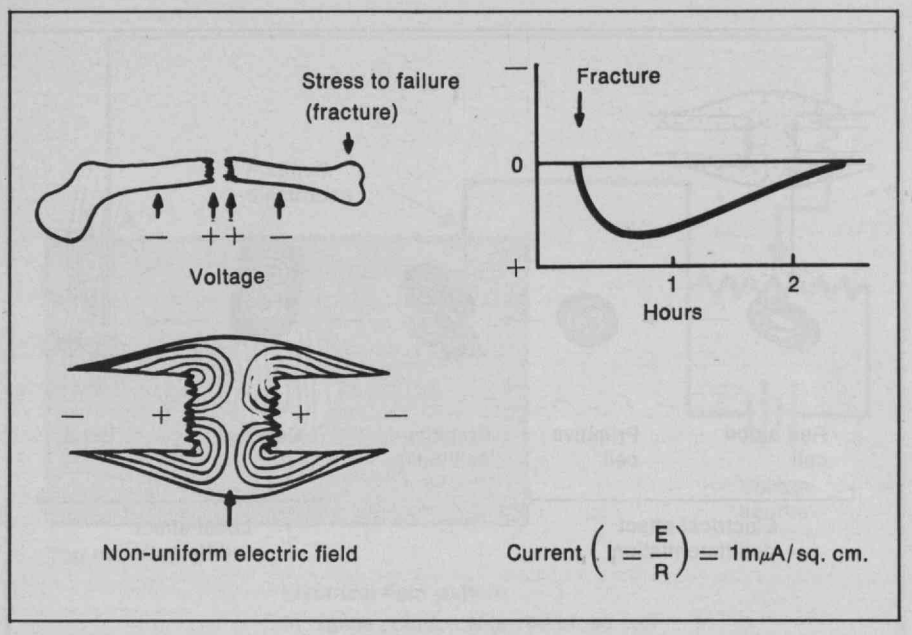
This simple block diagram illustrates the control system which regulates the growth of bone in response to mechanical stress (short of failure) in all mammals, as postulated by the author. The author confirmed this hypothesis by finding differential bone growth resulting from appropriate electrical signals introduced into nonstressed areas of bone.

Fracture Healing

We encountered considerable difficulties in adapting to nerve tissue the type of solid-state physical analysis that we wished to apply in order to establish the effects of electromagnetic forces. So we then turned to a study of bone from this point of view. This was a fortuitous choice, since—though bone has no nerve supply—it still evidences several types of clearly identifiable growth response which could be subject to control systems analysis. One such growth process in bone is its ability to anatomically restructure itself to best resist the mechanical stresses applied to it—an ideal input-output system. Another growth phenomenon of interest is fracture healing—the only true regenerative growth process still available to the mammal.

A portion of the bone matrix, the collagen fiber, had already been shown by Professor Eiichi Fukada to have piezoelectric properties; we extended this study and were able

Disturbances in the earth's electromagnetic field are statistically related to behavior disturbances in the human population



Mechanical stress to failure—the fracture of bone—leads to electrical activity of a kind very different from that involved in the gradual response to mechanical stress. In the former case, the stimulus stems from an interaction of electrical potentials in the damaged bone matrix and in damaged nerves in the extremity. The result is basically an opposed dipole which persists for several hours, in contrast to the signals from stressed but undamaged bone with time-constants in the range only of seconds.

to demonstrate that the collagen molecule, in addition to being piezoelectric, was an N-type semiconductor, while the mineral crystals closely applied to the collagen were P-type semiconductors. (These two semiconductors differ in the following way: current will flow from a P-type to an N-type material but not in the reverse direction.) With this knowledge, we could theorize a control system governing the growth of bone in response to mechanical stress that utilized a rectified electrical signal produced by the bone matrix when stressed. Such signals were found, and when devices which simulated such signals were inserted into non-stressed areas of bone, appropriate differential bone growth ensued. We have made many studies of the solid-state properties of bone and have reported a considerable amount of interesting data to support this view of how bone growth responds to physical stress.

The healing of bone fractures is a completely different growth process. Our first effort was to seek an electrical signal that resulted from stressing-to-failure of bone material, and such a signal was indeed identified. When applied *in vitro* to cells that produce new bone, a similar electrical signal in fact induced changes identical to those observed at the fracture site. We were soon able to integrate these observations into a control system that regulated fracture healing.

It should now be emphasized that both of these control systems are essentially self-contained; they fit the category of self-organizing systems, and they are in fact relatively simple closed-loop, negative feedback systems.

Toward Human Regeneration

The distinction between bone response to stress and to fracture lies in cellular changes which seem to be of great importance. In the case of fracture repair, we found that certain cells under appropriate electrical stimulation (direct current in $\mu\mu$amp. ranges) would undergo reversion to a more primitive cell type (dedifferentiated), and that this primitive material was subsequently redifferentiated into those cell types needed for the particular tissue repair process required. We were able to study some of the electrical parameters of importance; the most outstanding was that the effective levels of voltage and current had both upper and lower limits. In other words, voltages or currents above an upper limit were nonproductive of cellular changes until current densities became high enough to produce heating effects.

The fracture healing process is an example of regenerative-type growth; new *bone* tissue is regrown, and no scar tissue is formed. Thus we were able to use the information gathered in the fracture study to synthesize a theoretical control system regulating regenerative growth in general. On that basis we postulated several points in the control system where mammals, including man, might be deficient and so unable to achieve regenerative growth—except in the limited case of bone fracture repair. Correcting one or more of these

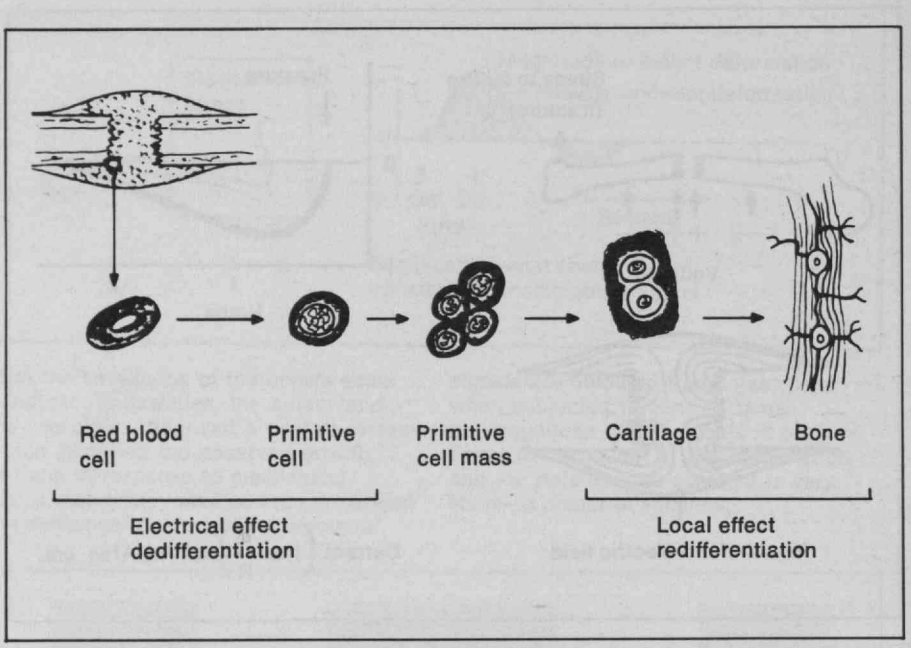
theorized deficiencies might lead to the capability for regenerative growth in man. The clinical importance of this concept lies not in the possibility of achieving limb regrowth for humans, but rather in the possibilities it opens for the control of growth processes to achieve more effective healing.

For example: a heart attack results in the death of a portion of the heart muscle; the normal healing process is the production of scar tissue across the area. Multiple scar formation obviously results in diminished functional ability of the heart as a pump. At the present time only three therapeutic methods seem to be available: grafting of additional blood vessels to the heart with the intent of preventing additional attacks, heart transplant, and—possibly—mechanical hearts of various types. None of these is particularly efficient, most are experimental in nature, and one can reasonably predict great difficulties in developing these as effective, large-scale therapeutic methods.

But we have found that some animals capable of regrowing limbs can also regrow portions of the heart muscle. The control mechanisms for both these types of regenerative growth appear to be the same. If we could gain access to these control systems in an effective fashion, we would be able to bring about the repair of damaged heart muscle by growing new heart muscle instead of scar. Similar applications can be envisioned in many other areas of clinical medicine; probably the most fruitful for early application would be in the bones and joints.

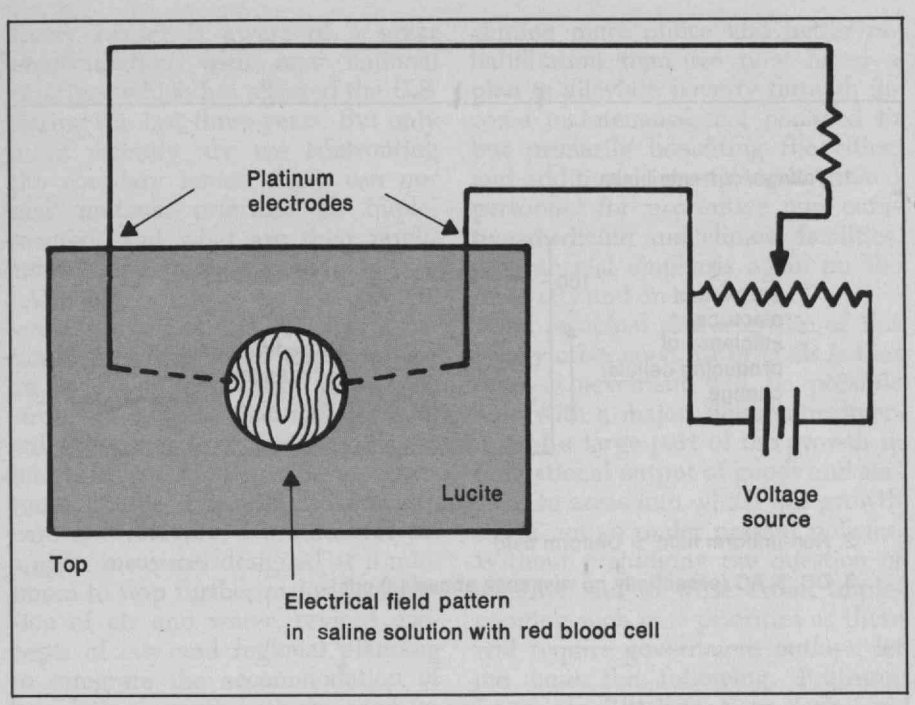
We theorize that one reason why mammals cannot achieve many kinds of regenerative growth is the absence of adequate electrical factors at the injury site. Acting on that hypothesis, my laboratory initially undertook a study of limb regeneration in the white rat. The theoretical current/voltage requirements were small enough so that we could consider bimetallic electrogenic couplings as a power source; similar devices had been used by Professor Stephen Smith in 1967 to restore some measure of limb regeneration in the frog, an amphibian capable of limb regeneration when in the tadpole stage but lacking this ability in adulthood. We investigated these devices and found that Smith's simple, silver-platinum junctions produced currents approximately five times those required. We resolved this problem by inserting miniature carbon resistors of various values between the silver and platinum, encapsulating the entire device in silicon.

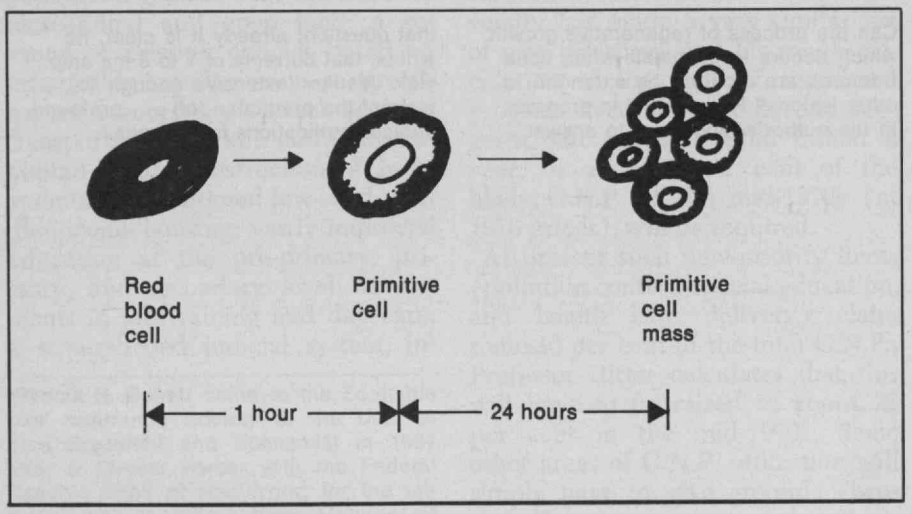
Such devices inserted into the amputated forelimbs of 21-day-old white rats resulted, in a high percentage of cases, in the regrowth of an organized, multi-tissue portion of the mission extremity. Bone cartilage, bone marrow, muscle, nerve, and blood vessels all were regenerated. While a complete extremity was not formed in any case, the amount and organizational pattern of the units formed far exceeded any growth naturally seen or previously obtained by any technique.



Distinctive cellular events stemming from nerve/bone electrical potentials are associated with fracture healing in all vertebrates other than mammals, and the author proposes that they also occur in bone marrow cells in the fracture healing process in mammals. The events of interest consist first of dedifferentiation of red blood cells into primitive cells and cell masses, and then the redifferentiation of the latter into cartilage and bone. The fracture healing process is the only example of regenerative growth known in mammals.

Successful experimental regrowth of a cell population by electrical energy application warrants a prediction of profound clinical implications for humans





This diagrammatic representation (top) shows the author's method of obtaining primitive regenerative growth by simulating the levels of electrical currents and fields which he found to in fact prevail at the site of a bone fracture in a laboratory mouse. Direct currents in amp. ranges are used to create an electrical field in a saline solution containing red blood cells. Within an hour these cells have begun a process of redifferentiation into more primitive cells (below), and within 24 hours large numbers of such primitive cells are available. Then can begin the process of their redifferentiation into the various cell types required for the tissue repairs.

The importance of this observation is two-fold. The growth pattern makes it clear that the effect of the electrical energy was to bring about dedifferentiation of a cell population and its subsequent regrowth and redifferentiation, with the expression of multiple genetic pathways (i.e., the controlled reading-out and application of the all-purpose structural information that all cells possess—the process which occurs in its most complete form during the development of an embryo). And the results produced in response to the level of current used (a total of 1 to 3 mμamp.) were extensive enough to warrant the prediction that similar-level currents could have profound clinical implications for humans.

Unravelling the Control of Life

We therefore now believe that low-level electrical currents and potentials, produced either by direct injection or by rectification and induction from a field, have the capability of bringing about very major biological effects of a very basic nature. The changes appear to be based upon perturbations produced in pre-existing biological electronic control systems which regulate very basic life functions. They hold significant promise for better understanding of life control systems and for clinical application to certain diseases.

But the present rapid proliferation of techniques and devices utilizing electrical currents and potentials in the treatment of various clinical conditions seems to be unjustified and indeed alarming; and I am particularly concerned that the very real dangers appear not to have been considered very thoroughly by any of the groups occupied with clinical

applications.

I also feel concern for a much broader problem, which is the continuous exposure of the entire North American population to an electromagnetic environment in which is present the possibility of inducing currents or voltages comparable with those now known to exist in biological control systems.

I am not suggesting that all clinical investigation of this modality be terminated; however, I do believe that it should be subject to the same types of controls imposed on the use of experimental drugs. Nor am I suggesting that all use of radio-frequency radiation be terminated; however, the application of energy in new spectral regions or increases in current field densities in metropolitan areas should be carefully evaluated.

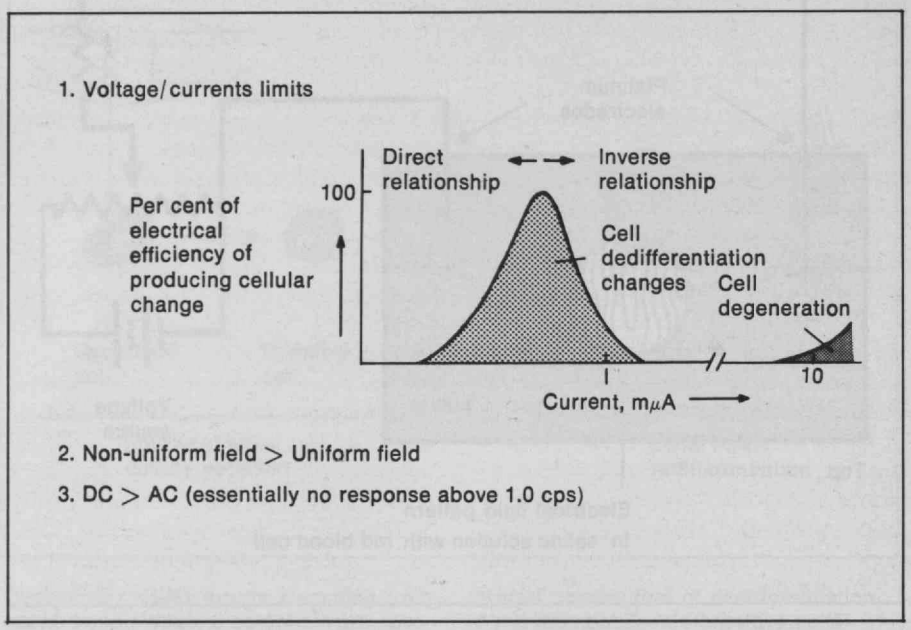
What I feel is urgently required is multidisciplinary research on the entire problem of electromagnetic energy and biological systems, covering all areas—the direct injection of electrical current into living systems, their exposure to radio-frequency fields, and pre-existing basic biological electronic control systems. My conviction is that this field holds promise of containing the next great advance in biomedical science.

Suggested Readings

Becker, R. O., and D. G. Murray, "The Electric Control System Regulating Fracture Healing in Amphibians," *Clinical Orthopedics and Related Research,* Vol. 73, pp. 169-98, 1970.

Frost, Harold M. (ed.), *Bone Biodynamics.* Boston: Little Brown and Co., 1964.

Szent-Gyorgyi, Albert, *Introduction to a Submolecular Biology.* New York: Academic Press, 1960.



Can the process of regenerative growth which occurs in mammals when bone fractures are repaired be extended to other lesions? Research is in progress in the author's laboratory to answer that question; already it is clear, he writes, that currents of 1 to 3 mμ amp. yield results "extensive enough to warrant the prediction (of) . . . profound clinical implications for humans."

Francis H. Schott
Vice President
Equitable Life Assurance
Society

The New-Priority Problem

New technology, and new accounting, may together show us how to resolve what now appears to be an irresolvable conflict between economic growth and new national priorities.

Every reader is aware of a great preoccupation with new national priorities which has affected the U.S. during the last three years. But only more recently are we confronting the corollary issues: How can our new national priorities be implemented; and what are their implications for economic growth?

Although almost everybody will want to make up his own list of national priorities, I am impressed by an emerging consensus sufficiently strong to suggest that major action will be taken over the next five to ten years on problems of the environment, the inner city, and health care and delivery. I predict, for example: measures designed at a minimum to stop further major degradation of air and water; revised concepts of city and regional planning to integrate the accommodation of population growth with the need for recreational and open land; a revision of existing policies based on exhaustible supplies so as to stretch natural resources; an attack on mass transportation within entire metropolitan areas; construction of large amounts of additional low- and middle-income housing; vastly improved education at the pre-primary, primary, and secondary level; investments in job training and day care; a strengthened judicial system, including more police and better rehabilitation than we now have; a plan to alleviate poverty through income maintenance, not confined to but primarily benefiting the cities; and additional investment in trained personnel for preventive and curative medicine and clinical facilities, with special emphasis again on the inner city and on rural areas.

One principal characteristic of this or any other such list of goals is that their achievement will be possible only with a major, deliberate diversion of a large part of the growth in the national output of goods and services to areas into which this growth might not go under present policies. Without prejudging the question of whether and to what extent implementing such new priorities as these will require government outlays, let me note the following. Professor Lawrence Ritter of New York University has made a very similar list of new priorities, and his rough calculation of the costs of significant progress over the next decade suggests that an extra $100 billion a year, or about 7 per cent of the likely G.N.P. of the mid-1970s (at 1970 prices), will be required.

At present such new-priority items (pollution control, special education, and health care delivery) claim some 16 per cent of the total G.N.P.; Professor Ritter calculates that this will have to be raised to about 22 per cent in the mid-1970s. Some other areas of G.N.P. utilization will simply have to give ground. Theoretically, these areas of less-than-average total real G.N.P. growth could include any federal, state, and local expenditure items—such as defense, agricultural support, and highways—which do not satisfy the new priorities; the reductions could also come in business investment, net exports, or personal consumption. In practice, the prime candidate for a relative (although not an absolute) slowing in growth will probably be private consumption, which now accounts for nearly two-thirds of G.N.P.

Can the Government Stay Out?

Although there is no logical necessity for bringing about socially desired economic objectives through additional government taxes and expenditures, the possibility of doing so illustrates most clearly the principle of resource reallocation. A simple analogy is the case of wartime economic policy, in which any non-inflationary diversion of resources into defense has to be accomplished by larger taxes on private incomes—personal or corporate; the funds corresponding to decreases in private-sector spending are channeled into additional government purchases of defense material and into a larger military payroll.

In the case of the new priorities, however, the question of implementation is far more complicated, because the appropriate mechanisms obviously—and fortunately—can be subjected to a far more detailed cost-benefit analysis than can defense expenditures. While the average citizen and even Congressmen can only gnash their teeth in frustration at cost overruns and technological mistakes in defense—because defense can be handled only by centralized authority—society still has freedom of choice in dealing with the challenge of implementing the new priorities.

The challenge begins right at the starting line: How are we appropriately to measure cost-benefit ratios? The merest hints will have to do

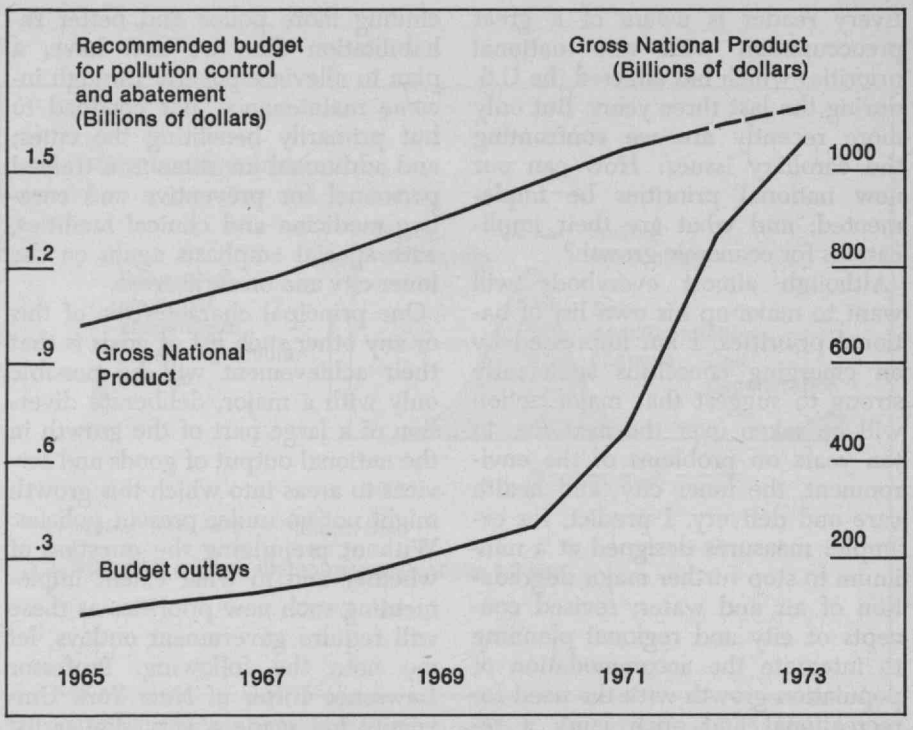
Francis H. Schott came to the Equitable Life Assurance Society of the U.S. as Vice President and Economist in 1967 after a 15-year career with the Federal Reserve Bank of New York; for the latter he was at various times Manager of the Research and Foreign Departments and Editor of the *Monthly Review*. Mr. Schott studied at Oberlin College and Princeton, and he is Adjunct Professor of Economics at Baruch College of the City University of New York; this article is drawn from his remarks to a seminar of the M.I.T. Alumni Center of New York in the spring of 1972.

at this point.

We are all aware that there is such a thing as an excessive burden of government on citizens. And we are beginning to see that society may also impose an excessive burden (of expectations) on government. The repeated failures of massive bureaucracy, for example, to move the Soviet economy forward at "target rates" should serve as a clear warning to us, quite apart from ideology. We are beginning to understand that to improve our chances for favorable cost-benefit ratios, we must evaluate carefully the alternatives to direct government programs.

One alternative is new ventures in what has been termed third-sector activity—mixtures of government and private enterprise such as COMSAT, the new Postal Service, voluntary hospitals, and the emerging nonprofit health maintenance organizations. The originator of the term "third sector", Amitai Etzioni, says in an article in the first issue of *Business and Society Review* that "success, efficiency and power in dealing with social problems may lie with a kind of 'quasi-public' organization that is neither wholly public nor wholly private." We may also decide to use tax incentives and disincentives to move the private sector in desired directions without direct government involvement. The proposed tax on lead additives in gasoline is an illustration.

But in spite of these possibilities, implementing the new priorities will in all likelihood involve some rise in government's share of total spending and hence in the taxation of private income to finance such spending. Anyone frightened by this possibility should remember that the U.S. continues to have one of the lowest government-spending-to-G.N.P. ratios among Free-World countries. The "Brookings Study" by Charles Schultze and Associates (cited in the Suggested Readings at the end of this article) faces this issue head-on.

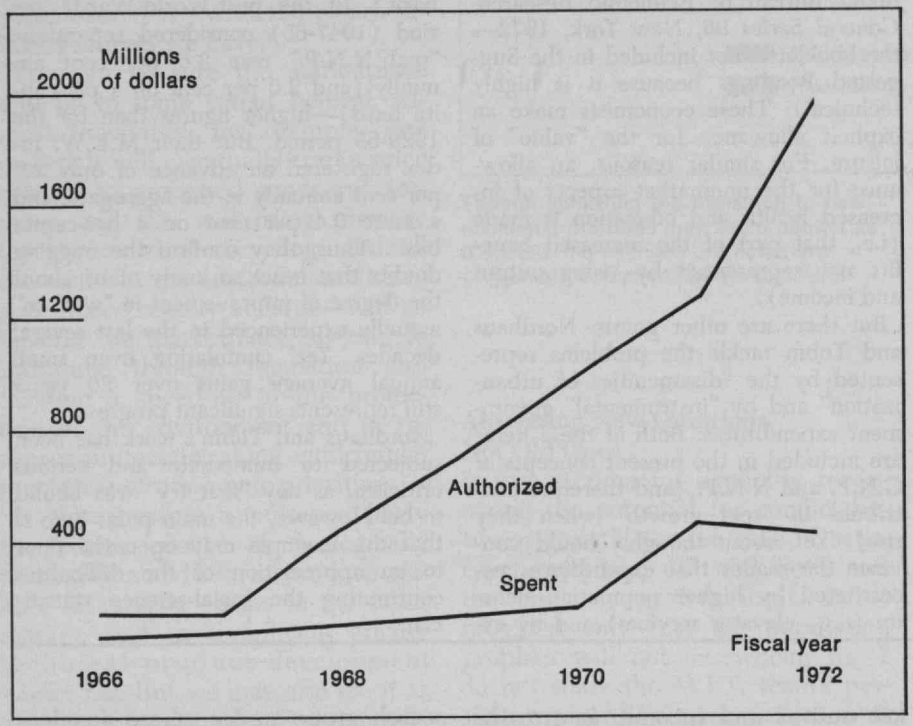


Budget outlays for pollution control and abatement have increased sharply since 1970, contrasting with the continuing gradual climb of gross national product. This argues that such new-priority demands on U.S. productivity must ultimately rise to conflict absolutely with the "growth" ethic of the U.S.—unless our concepts of "growth" can be changed. (Data: U.S. Budget)

Challenging Faith Even as Galileo

I now come to the question of the relationship of new priorities to economic growth in general. It is very clear that the demands of the new priorities, whatever they turn out to be, can be met more easily if society does not have to forego growth and so can achieve its new goals by allocation out of growth in the more conventional activities. All such calculations as the one by Professor Ritter rest on the prediction that long-term real growth in G.N.P. will continue at some rate such as 4 to 4½ per cent per year. Without such growth, the consequences for the old priorities of implementing the new priorities appear to be very serious.

But there is now emerging a new issue in the argument, owing to Professor Jay Forrester and his associates Donella and Dennis Meadows. Using systems models, they set out to prove that economic growth must come to an end within the next century or so. They propose that a continuing exponential rise in nonrenewable resource utilization and/or pollution, partly induced by pop-



But the challenge of new priorities to growth (see chart opposite) may be more illusory than real—at least for the present. Though the Congress has authorized ever-growing expenditures for water pollution control since 1970, only one-fourth of the available funds have been spent thus far. "Red tape" is the usual explanation. (Data: Engineering News Record)

ulation growth and partly by the rise in *per capita* consumption, may bring about a collapse. Furthermore, the U.S. bears an especially heavy responsibility on the side of potential disaster since we account for one-third of nonrenewable resource use with only six per cent of the world's population.

The seriousness of this challenge to the new priorities is difficult to evaluate. Quite clearly, the initial "establishment" reaction (including that of economists of virtually all shades of political persuasion) was negative. Some of the reasonable criticisms relate to the mechanical nature of the model—anything assumed to be growing exponentially *ad infinitum* will eventually overwhelm all else on earth. And the book through which most readers have learned of the work—*The Limits to Growth*—suffered seriously because it did not present the underlying data and model structure; no one could check the facts and figures for himself until the publication, much later, of *Dynamics of Growth in a Finite World.*

Yet criticisms of this kind are not the basic cause of the negative reaction. The real trouble is that people feel the predictions to constitute a well justified dire warning with which they do not at the moment know how to cope. The book challenges faith as Galileo did.

In appraising this feeling of unease it should be kept in mind that *The Limits to Growth* is itself a product of the current environment. There is enough evidence at hand to justify the grave apprehensions expressed. We know a lot about critical water pollution in Lake Erie, air pollution over Los Angeles, and impending energy shortages—enough to realize that the M.I.T. project people are not just dreaming.

But what *is* a reasoned reaction? Here is a sketch, certainly not yet worked out thoroughly but related as much as possible to the new-priority problem.

First, let me note that the clash between *The Limits to Growth* and the demands of the new priorities is not a total one. There is no disagreement when it comes to the population problem. Population increases complicate attainment of old and new priority aims alike by forcing economic growth simply in order to stand still in *per capita* terms. Take an example from the old priorities—increasing the supply of traditional consumer goods. This involves gradual exhaustion of possibly nonrenewable natural resources. Surely, the dilemma will be eased to the degree we can use up such resources more slowly by slowing or halting population growth. Or take an example from the new priorities, the environmental one. Clean air and water are less costly to attain the less additional population growth occurs; in fact, less people probably means a disproportionately lowered *per capita* cost of the environmental cleanup.

This point of clarification however, is somewhat academic, for population is bound to grow for many more years. Even if the fertility rate were

Restructured G.N.P. Accounts: An Explanation and an Example

Gross National Product is a measure of the market value of the total output of goods and services at current prices—the most aggregate gauge of economic activity currently available. G.N.P. contains an allowance for business capital depreciation, subtraction of which yields "Net National Product"—N.N.P. (This concept should not be confused with "net output" as used in the text.) Deflating N.N.P. by price rises gives us a measure of "real economic growth." This is the figure that should be at issue in discussing what, if any, growth has taken place in the past, and whether and how much future growth is desirable. Naturally, the population issue intrudes immediately since real economic growth differs substantially over a longer period depending on whether "N.N.P. at constant prices" is measured in absolute or in *per-capita* terms. Traditional welfare-oriented economics has tended to emphasize the *per-capita* measure; the radical ecologist would presumably declare population growth "part of the problem" and put all the emphasis on the absolute measure (which he would seek to curb regardless of the welfare consequences on a *per-capita* basis).

The current National Bureau of Economic Research (N.B.E.R.) study mentioned in the text includes a search for answers to the question how one might allow for the nondollar benefits of clean air and water (left out of G.N.P. up to now because of their nonmarket character), and the reduction of these benefits because of despoliation.

Logic being what it is, bringing up the issue of nonmarket activities at all forces consideration, in restructuring national accounts, not only of "free" air and water but also of numerous other such activities—and of nonactivities, including leisure! Surely, the "voluntary" long-term decline in the average work-week should be counted as a gain in welfare, just as pure (or purer) air should be.

This is one of the main points made by Yale economists William Nordhaus and James Tobin on behalf of the N.B.E.R. in a challenging "first try" at revised historical national income accounts ("Is Growth Obsolete?", National Bureau of Economic Research, *General Series 96*, New York, 1972—the booklet is not included in the Suggested Readings because it is highly technical). These economists make an explicit allowance for the "value" of leisure. For similar reasons, an allowance for the nonmarket aspects of increased health and education is made (i.e., that part of the increased benefits not represented by rising output and income).

But there are other points. Nordhaus and Tobin tackle the problems represented by the "disamenities of urbanization" and by "instrumental" government expenditures. Both of these items are included in the present concepts of G.N.P. and N.N.P. (and therefore contribute to "real growth" when they rise). Yet, some thought should convince the reader that expenditures necessitated by higher population density (e.g., elevator services) and by external and internal threats (e.g., defense and police) do not contribute to "economic well-being", in spite of their monetary measurability. On the other hand, the "deterioration of the environment" is not in fact subtracted by Nordhaus and Tobin (the N.B.E.R. is now getting to this problem).

The authors finally develop three variants of a "'Measure of Economic Welfare" (M.E.W.), which show roughly the following: Between 1929 and 1965, conventionally defined "real N.N.P." rose 3 per cent annually (1.7 per cent on a per-capita basis). Their preferred variant of M.E.W. rose at 2.3 per cent annually over this period (or 1.0 per cent on a per capita basis). In the post-World-War-II period (1947-65) considered separately, "real N.N.P." rose 3.6 per cent annually (and 2.0 per cent on a per-capita basis)—higher figures than for the 1929-65 period. But their M.E.W. index registered an advance of only 2.0 per cent annually in the aggregate, and a mere 0.4 per cent on a per-capita basis. Thus, they confirm the nagging doubts that beset so many of us about the degree of improvement in "welfare" actually experienced in the last several decades. Yet, cumulating even small annual average gains over 20 years still represents significant progress.

Nordhaus and Tobin's work has been subjected to immediate and serious criticism, as any "first try" was bound to be. However, the main point here is that this example may open the door to an appreciation of the difficulties confronting the social-science statistician.

to drop to the replacement rate now, the U.S. population would level off only in another 75 years at around 280 to 300 million. The fact is that we must cope with the new priorities within the context of population growth, although the question of degree remains very much open because of the uncertainty of future demographic trends.

Growth: Gross vs. Net

A straightforward confrontation of the dilemma of growth versus the new priorities begins with two partial answers: a redefinition of growth itself, and the assumption of new directions in technology. We must come to realize that market output and income (deflated by the price level) may not be the one and only relevant measure of "growth".

In effect, our present G.N.P. accounting system says that polluting activity, as long as it produces market output and income, *is* growth. This is also true of anti-polluting or depolluting economic activity (with the same qualification). Thus, a situation exists in our present accounting in which so-called growth is stimulated doubly: the more you pollute the more you grow, and the more you then offset the adverse effects of pollution the more you grow again. The question is, however, whether human welfare actually benefits on balance from this type of growth. If the degree of pollution is the only consideration, it obviously does not. We are exactly as well off before and after the mutually offsetting activities have occurred.

Hence, an alternative system for aggregate economic output accounting has been proposed in work underway at the National Bureau of Economic Research (the leading university-sponsored nonprofit research group under whose auspices much of the present aggregate economic accounting system was developed originally). The new plan is to distinguish between gross and net output, so that in the case described it would become clear that only gross output and not net output has gone up. This procedure implies that "net growth" as a target might involve policies and measures of accomplishment sharply different from our present concept of growth (see insert above).

The great advantage of the proposal is that its implementation would make us more realistic about how economic growth as now measured related to human welfare. But it is obviously not a complete answer—because raising gross output involves more employment and money income, whereas raising net output may or may not; and because employment or lack thereof is surely

a valid measure of welfare, too. Furthermore, the proposal is no answer in the case of those new priorities where we are talking only about reshuffling capital and nonrenewable resource use between items no one of which is *a priori* environmentally more advantageous than any other.

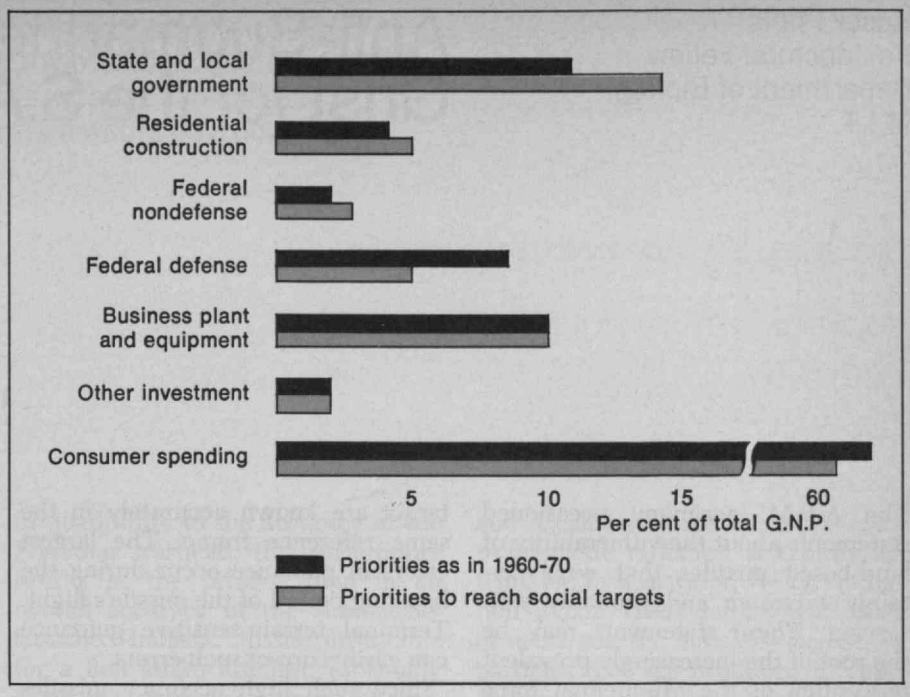
Turning Pressure Into Opportunity

In these important respects there remains a conflict between the claims of new priorities and the problems growth brings. Yet there may remain an additional alternative: Can we find through technology new ways to reconcile our desire for "more" (whatever it is) with the clearly finite resources we have?

You can be sure the marketplace will be to some extent helpful. Almost inevitably, for example, raw materials will eventually rise in price relative to processed goods and services, and this will bring pressure for economizing, recycling, and all the rest. But the environmentalists—and indeed society at large—will go beyond the marketplace, seeking to introduce through regulation and taxation a speed-up in the protection of the environment and in resource protection, along with implementation of other new priorities.

Is this pressure a nuisance likely to reduce profits in ecologically damaging activities; to produce sizable dislocation effects in the labor market; and to complicate greatly technical product development work? Yes. But we may also see it as a creative opportunity. For example, I believe that the aggregate transportation problem can in fact be handled in a net-welfare-increasing fashion. But the calculations have to allow for the possible lower cost-benefit ratio of mass transportation for society as a whole.

The costs of additional private automobiles should include explicit allowances for highway construction, land use and pollution per car. These costs must be borne by society whether or not they are—or can be, or should be—explicitly allocated to the car purchaser. Corresponding costs for mass transportation are likely to be less, at least in metropolitan areas. The result may be tilted further in that direction if the technological quest toward cost reduction is redirected in full awareness of all the costs relevant to society as a whole.



Though achieving the transition to new economic priorities may seem painful as it occurs, the changes projected are very small increments of the total U.S. Gross National Product. This analysis is by Lawrence S. Ritter in the *Morgan Guaranty Survey* for July, 1971.

Answering New Questions, Not Old Ones

It is past time for explicitly recognizing the potential for conflict between growth, for the sake of satisfying priorities, old and new, and the limits to growth itself. But—provided only that the population problem will not overwhelm us—I do not share the M.I.T. team's pessimism regarding a reconciliation of the admitted clashes. It is paradoxically but hopefully true that their success as propagandists may defeat them as prognosticators.

Nor should engineers and technologists be disheartened by their message. Engineers must in these times be assailed by the kind of self-doubt that has plagued the atom smashers ever since their monumental achievement. Economists will likewise have to do much more work than these preliminary thoughts to reconcile their previous faith in growth as an answer to most problems with their new awareness of the limitations of that answer. But all of us heard in college that it is the ability to search for answers to difficult questions that counts—not the answers we learned, since these (and the problems) would change. We have to live with that message.

Suggested Readings

Etzioni, Amitai, "The Untapped Potential of the 'Third Sector'." *Business and Society Review,* Boston, Spring 1972, Number 1, pp. 39-44.

Gaines, Tilford, "The Doomsday Debate." *Manufacturers Hanover Trust Economic Report,* New York, March 1972.

Juster, F. Thomas, "On the Measurement of Economic and Social Performance," *50th Annual Report.* New York: National Bureau of Economic Research, 1970, pp. 8-24

Meadows, Donella H.; Meadows, Dennis L.; Randers, Jorgen; Behrens, William W., *The Limits to Growth,* A Potomac Associates Book. New York: Universe Books, 1972.

Ritter, Lawrence S., "The Political Arithmetic of Reordered National Priorities." *Morgan Guaranty Survey,* New York, July 1971, pp. 3-9.

Schott, Francis H., "Implementing the New Priorities," *1971 Business and Economics Statistics Section Proceedings.* Washington: American Statistical Association, pp. 168-176.

Schultze, Charles L.; Fried, Edward R.; Rivlin, Alice M.; Teeters, Nancy H., *Setting National Priorities—The 1973 Budget.* Washington: The Brookings Institution, 1972.

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Anti-Submarine Warfare: Grist for the S.A.L.T. Mill

The A.B.M. acrimony occasioned statements about the vulnerability of land-based missiles that were certainly excessive and probably self-serving. These statements may be the root of the increasingly prevalent perception of the Minuteman force as a non-credible deterrent to a nuclear attack against this country. A more realistic view would be that land-based missiles are unsuitable for deterrence since their great accuracy puts a potential adversary on edge, and their fixed targetable location tempts him to do exactly what they are designed to prevent—i.e., to launch a nuclear attack against the United States.

At the present time each of the three independently targetable warheads of a Minuteman III has an accuracy that is measured in the hundreds of feet. But little except money prevents this figure from being lowered by an order of magnitude with the introduction of post-boost guidance or even terminal guidance. Such advances may force the reduction of the warhead yield because they require additional space on the reentry vehicle, but they can improve the accuracy of the weapon substantially since the positions of the firing platform and the target are known accurately in the same reference frame. The largest errors in guidance occur during the boosting period of the missile's flight. Terminal terrain-sensitive guidance can easily correct such errors.

Since such high accuracy missiles are unnecessary for extended, soft targets like cities or industrial complexes, an adversary is forced to assume that they are meant to destroy his own land-based missiles, inside their hardened silos; an operation that indeed requires both exquisite accuracy and the certainty that the launched missiles have performed as expected. Such a fearful assumption however may induce the opponent to react preventively, either in a calculated or even a reflex fashion, by attempting to eliminate our land-based missiles in a preemptive, damage-limiting first strike. Such an attack is possible since the opponent knows exactly the location of the Minuteman force and possesses reliable weapons capable of destroying it. The accurate, targetable land-based weapons, that allow for a quick replacement of a missile by another targeted on the same target if the original one malfunctions, can indeed deter all but a suicidal adversary from attacking this country. At the same time however their vulnerability causes the "crisis instability" which at the present time may be the source of the gravest nuclear threat to the United States. (In his first article on disarmament, published in October/November, Dr. Tsipis discussed the strategic stability that the S.A.L.T. talks aim for, and the ways in which various new weapons systems endanger it.—Ed.)

Silent, Swift, a Little Inaccurate

By comparison, the submarine-launched ballistic missile (S.L.B.M.) is the "ideal weapon" for deterrence. The ballistic missile-carrying submarines have no tactical capability either against surface shipping or against other submarines. Their object is not to attack another vessel but to remain undetected and within range of their land targets. Therefore their operations differ sharply from those of hunter-killer submarines and tactical submarines designed to interfere with shipping or to attack the aircraft carriers. Each of the 41 Polaris submarines that constitute the U.S. S.L.B.M. force carries 16 missiles, each of which has, in the case of the Poseidon system that will be installed on three-quarters of the Polaris submarines, ten independently targetable warheads. The range of each of these 50 kton T.N.T.-equivalent warheads is reported to be about 3000 miles. Since no point on land is further than 1700 miles from the sea, Poseidon warheads can reach any target on an opponent's land mass. All ten Poseidon warheads can be aimed at the same target, or each can be aimed independently from the rest at a separate target. These separate targets however must lie in a corridor roughly 50 miles downrange, and 30 miles wide. The accuracy of these warheads is about one-quarter of a mile.

The Polaris submarines that serve as launching platforms for the Poseidon missiles are quiet, nuclear powered vessels limited in their capability to remain submerged on station by crew endurance, the amount of provisions they carry, and the need for servicing and maintenance. They can descend to depths of at least 1000 feet, but probably not to twice that. They are swift ships, probably capable of more than 20 knots when submerged.

Kosta Tsipis has been involved for several years with the United States Pugwash group; this year he is its Executive Secretary. He also teaches at the summer course on disarmament offered by the Italian Pugwash contingent. His academic interest is presently biophysics—he is on leave to the Biology Department, having been since 1967 Assistant Professor of Physics at M.I.T. in high-energy physics. Dr. Tsipis studied at Rutgers (B.S. in electrical engineering, M.S. in physics) and Columbia (Ph.D. in physics, 1965). This article is a sequel to his paper on "Strategic Stability, with S.A.L.T." in *Technology Review* for October/November.

Our best nuclear deterrent is the Polaris submarine and the missiles it carries; but it is technically possible to build a system that would detect these submarines in the ocean and make possible their destruction. That system would be a new A.B.M.

However, when on station they cruise at a fraction of that speed since at lower speeds they are practically noiseless. At cruising speed a Polaris reportedly emits less than one milliwatt of acoustical power.

Each Polaris submarine has three inertial navigation systems (S.I.N.S.) on board. With the aid of the on-board computer, these systems provide accurate navigation data needed not only for the navigation of the vessel but also for the preparation of the missiles for launching. The intrinsic precision of a S.I.N.S. is probably extremely good. However small errors are cumulative and after a few days of cruising it needs updating with accurate position information provided by external sources such as satellites or underwater transponders. With such updating the position of the submarine at the instant of a missile launch can be known to a few hundred feet. Updating the S.I.N.S. while the submarine is cruising underwater, however, is difficult because electromagnetic waves, the most convenient and efficient carrier of information, are completely attenuated after travelling a few feet in seawater.

The opaqueness of the ocean gives the submarine its great advantage as a deterrent. The strong attenuation of electromagnetic waves by sea-water renders the submerged submarine not only practically incommunicado but also invisible. It couples tightly invulnerability and reduced missile accuracy. The submarine cannot be detected by means of electromagnetic radiation; therefore at the present it is invulnerable to surprise attack. But its inability to communicate while invisible makes the uncertainty in its position at launch-time rather large. Added in quadrature to the accuracy of the Poseidon warhead, this uncertainty results at the present time in an overall accuracy of the submarine-launched ballistic missile unsuitable for a first strike attempt, especially since the warhead is only 50 kilotons. In addition, it is almost impossible to ascertain whether a given Poseidon warhead has malfunctioned or not, to say nothing of trying to replace it by another one on the same intended target.

Still, even a relatively inaccurate, non-reprogrammable nuclear weapons system is highly effective against soft targets and therefore constitutes a reliable deterrent. Unable to threaten the vectors of deterrence of an opponent, immune to a surprise attack, yet capable of completely devastating the urban and industrial centers of a nation, the nuclear submarine appears to be the perfect vehicle of deterrence.

Threatened More by Fear Than Weapons

Often the deterrent value of submarines is questioned on the basis of the so-called "command and control" problem. It is argued that in time of war the missile-carrying submarines will have to remain submerged to insure their invulnerability from a first strike. While submerged, however, they cannot communicate with their command since electromagnetic waves are attenuated by the sea-water. Submarine commanders would thus be unaware of a strike against their country and would not know if and when to launch their missiles, especially if the national command authority has been destroyed in a first strike by the enemy.

This may not be as severe a limitation for submarines as it may appear, and it can be overcome. While electromagnetic radiation is rapidly attenuated by sea-water, "weak" radiation is not. Weak radiation consists of neutrinos, the massless, chargeless particles that are produced in copious quantities by high energy accelerators. Since they are not attenuated significantly either by water or by any other form of matter, an intense beam of energetic neutrinos produced by an accelerator can be aimed—through the center of the earth if necessary—at the various submarines cruising on station. The beam could be modulated to code for simple binary messages and could be detected on board a nuclear submarine. If the accelerator is located deep underground and its power supply is immune to a nuclear attack, it can provide a safe communications link with the Polaris submarines.

The deterrent value of submarines has also been challenged on the basis of recent reports of advances in the technology of underwater acoustical devices and digital signal processing: it is claimed that the S.L.B.M. force is rapidly becoming vulnerable to anti-submarine warfare (A.S.W.) measures of an opponent. These claims of vulnerability should be examined with great care. Historically, even when technically unfounded, such claims have contributed to the escalation of the arms race by inducing a sense of uncertainty and fear among strategic planners, political leaders, and the public. For example, Gallosh, the Soviet Union's A.B.M. system certainly did not *actually* threaten the efficacy of our deterrent; yet the doubt and fear it generated resulted in the deployment of M.I.R.V.s. The most destabilizing by-product of weapons technology is not in-

The deterrent value of submarines has been challenged on the basis of recent reports of advances in the technology of underwater acoustical devices and digital signal processing. These claims of vulnerability should be examined with great care.

vincible lethal artifacts but fear in the minds of people.

Before one can examine the validity of these vulnerability claims, one must define "vulnerability" in the context of a deterrent force. To threaten S.L.B.M.s as a component of strategic deterrence means to be able to destroy in a surprise attack, simultaneously, and upon command, all the Polaris submarines at port or on station in the oceans. If only two Poseidon-equipped submarines escaped, their combined complement of 320 warheads could destroy 50 large cities of the Soviet Union containing 30 per cent of the country's population and 50 per cent of the industry. A similar number would assuredly demolish 75 per cent of the industrial capability of the People's Republic of China. Even two Polaris submarines can inflict unacceptable damage and thereby even two constitute credible deterrence.

The Complex Technology That Is Needed

Let us consider now what it takes to wipe out *all* the Polaris submarines. It requires that an opponent can detect, localize, and track continuously and covertly thirty-odd nuclear submarines. Then upon command he must be able to deliver a lethal weapon against each one of them, while simultaneously he is attacking the land-based intercontinental ballistic missile force, those Polaris submarines in port, and the S.A.C. bombers. To attack only the S.L.B.M. force, or even to track it overtly, would obviate the advantage of a first strike attack. Such an operation is for all practical purposes technically impossible. But it seems to me that we do not even have to consider such a gradiose attack. Even the technical difficulties of a surprise attack against thirty Polaris submarines roaming submerged in millions of square miles of ocean are forbidding.

Since the sea is opaque to electromagnetic radiation, the opponent would have to rely upon acoustical means to detect the Polaris. But the sea is a noisy, inhomogeneous, and dissipative medium and the present A.S.W. systems are chiefly designed to protect point targets like aircraft carriers, rather than to attack missile-carrying submarines. One would envision the possibility that an adversary can track the Polaris submarines (with his own hunter-killer subs) from the moment they leave home port, and therefore be able to attack them upon command. Such an activity could not go undetected and it would deny the attacker the all-important element of surprise. Yet it is a threat to S.L.B.M. that merits further discussion.

The recent claims of vulnerability of the S.L.B.M. force, however, are not based on the efficacy of tracking, or on mines, or on barrier defenses against missile-carrying submarines during periods of declared war, but on the expectation of overcoming the technical difficulties that the ocean medium presents to long-range acoustical detection and localization of a submarine anywhere in it. Imagine a system consisting of underwater loudspeakers, or emitters as they are called in the literature, emitting megawatts of acoustical energy into the oceans in the form of low frequency sound waves, and microphones, or hydrophones as their underwater models are called, carefully listening for echoes that return after these waves are reflected by an object in the water. If this system used the proper wavelength—long enough not to be attenuated rapidly or disturbed by local medium inhomogeneities, but short enough to be reflected coherently by an object a few hundred feet long—and had the necessary resolution in range, azimuth, and bearing, it could electronically divide the ocean into cells the size of a submarine, interrogate each cell for the presence of a vessel in it, and thereby be able to localize simultaneously and identify a large number of submerged objects. Given enough logic and memory it would be able to discriminate subs from whales or schools of sardines.

Unbelievable as it may sound, such a system seems—in principle—within the present state of the technology. New prestressed ceramic transducers capable of supporting high energy densities permit the transfer of large amounts of acoustical energy of the right wavelength into the ocean. New electronic techniques of phasing an array of hydrophones and processing the incoming reflected signals can identify a submarine against the background noise, localize it, and track it unobtrusively for indefinite periods of time. Such a system can be built and deployed in the oceans of the globe if enough funds and resources are allocated to its realization. Physically it will consist of an array of hydrophones and transducers measuring a few hundred by a thousand feet, a communication link to a ground station, and what amounts to a large computer. For example, one can deploy a passive array of listening hydrophones either in a concentrated fixed array that sweeps the ocean and listens for the cavitation noises of a moving submarine, or in a disperse array that involves a matrix of upward-listening hydro-

The most destabilizing by-product of weapons technology is not invincible lethal artifacts but fear in the minds of the people.

phones distributed over large areas of the ocean. One can even have a hybrid system with the emitters mounted on a vessel and the hydrophones fixed. In a conceivable, even more sophisticated, system the emitters can be a source of a wide spectrum of acoustical frequencies, such as an explosion or a powerful underwater electric spark, that defies jamming. The ensuing discussion is equally applicable to these systems as well with small modifications.

To what extent such a system can overcome the inhomogeneities of the ocean medium, inhomogeneities that vary both as a function of location and time, is not known. It is certain, however, that this system is vulnerable both to attack and to countermeasures, as are all other weapons systems. In time of war it can be easily localized and destroyed. In time of peace submarines can evade detection by means of decoys or jamming. A country could place in the ocean devices that emit echoes like those produced by a submarine, for example. This acoustical array is the perfect model of the underwater A.B.M.: a weapons system of unknown actual efficacy, vulnerable, and subject to blackout and jamming, but threatening enough to cause alarm and initiate another round in the arms race, this time underwater. It is highly destabilizing, because it threatens the vectors of deterrence of the opponent without protecting one's own; and it is dangerous because it gives the appearance of satisfying the deeply-seated psychological need of this nation for an absolute sense of security.

Our "Unfulfilled Obsession"

Indeed the A.S.W. system described above may threaten the S.L.B.M. forces of any future adversaries. But experience has taught us that our adversaries are probably also capable of deploying a similar system, as they have been capable of building the atom bomb, then thermonuclear weapons, then intercontinental ballistic missiles, then nuclear submarines, then A.B.M.s and M.I.R.V.s. For 25 years we have witnessed the frantic but futile efforts of this nation to obtain such security by means of an absolute military superiority. That desire has remained, despite the colossal expenses, an unfulfilled obsession. What we have achieved instead is temporary technical superiority in some weapons systems, and an unstable relative security based on mutual terror. There is no technical reason to believe that this trend can be broken with underwater weapons systems.

The invulnerability of our sea-based deterrent can be safeguarded, not by a new technological advance —such advances rarely lead to actual increases in national security— but by international arms control agreements. The Moscow agreements on limiting A.B.M. and halting the numerical proliferation of offensive missiles offer an attractive paradigm. They have demonstrated how the bilaterally agreed-upon reduction of armaments can increase the national security of both countries.

The arms control agreements that will guarantee the invulnerability of our most credible deterrent are simple to implement and monitor unilaterally. The first measure in any international effort to protect the S.L.B.M. forces would be to forbid the installation of all large acoustical arrays, active, passive, or hybrid, capable of tracking nuclear submarines at very large distances. It is a relatively easy measure to enforce. No country has such arrays today, their efficacy is doubtful since it is not proven, and their cost astronomically high. Because of their size and easy detectability such arrays cannot be installed or operated clandestinely, therefore unilateral means of inspection can assure the continuing enforcement of any agreement. Their installation would not *actually* make S.L.B.M. forces vulnerable. It would rather raise *doubts* in the minds of everybody about their invulnerability. It is precisely these doubts that have animated the arms race to date: it is such doubts that have reduced our national security by inducing the deployment of superfluous arsenals of nuclear weapons aimed against this country.

And One More Threat

To forbid the acoustical arrays however will not eliminate the danger to our S.L.B.M. deterrent from the hunter-killer enemy submarines. Imagine an opponent that possesses 50 or 60 nuclear submarines equipped with sophisticated torpedoes, and further imagine that as soon as a Polaris leaves its home port one of these hostile submarines starts tracking it actively and overtly. It is quite easy to track a submarine with another for very long periods of time in that fashion. One can conceive of the unsettling possibility that at some instant in the future all our Polaris craft could be shadowed by the opponent. This is a much more dangerous situation than the one generated by the installation of acoustical arrays, because by tracking, the opponent not only can localize but also kill the Polaris fleet upon command. The tracking submarines can communicate with

The first measure in any international effort to protect the S.L.B.M. forces would be to forbid the installation of all large acoustical arrays. It would be a relatively easy measure to enforce.

their homeland while in the ocean since they do not try to hide. The element of surprise is lacking in this case, but still it is a real threat to our sea-based deterrent.

This threat can be removed by a second international agreement that would designate areas in the oceans accessible only to submarines of one nation. Each country with submarine-based nuclear weapons can have several such areas allocated to her fleet. These areas will of course have to be away from the lanes of maritime traffic, but they should be within missile range of the opponent's land mass. There are large parts of the South Atlantic, the North Pacific, the Indian Ocean, and even of the continental shelves of the submarine-equipped nations that might be so designated. The choice would depend on the technical capabilities of a given country's S.L.B.M.s, such as their range. Intrusion in these areas by submarines of another country can be declared a hostile act and countered in the same way that intrusion of hostile aircraft in a country's air space is dealt with today. Such a measure is again readily enforced and unilaterally verifiable. It does not degrade the efficacy of the sea-based deterrent, but on the contrary removes the last threat against it.

The proposed agreements do not run counter to the Navy's declared A.S.W. mission which is to "sink submarines!" The Navy's efforts are aimed against tactical submarines that may threaten sea-lanes and large surface craft. The proposed arms control agreements are designed to separate tactical from strategic submarines and deal with each type differently. As now defined, the Navy's mission would be incompatible with our declared national policy of deterrence if applied to strategic submarines, and therefore would not contribute to the security of the nation; on the contrary it would jeopardize it. By distinguishing operationally between tactical and missile-carrying submarines the proposed arms limitation agreements will actually complement the present A.S.W. efforts of the Navy.

Of course there will always be the occasional satanical Dr. Strangelove who will invoke some physical principle we know not of to conjure a non-existent new weapon that could possibly, but not probably, threaten our sea-based deterrent. But since nothing of the sort appears on the technological horizon, the prudent person should worry about the immediate threat of arms escalation in the ocean rather than about virtual dangers. The elimination of the A.S.W. threat against S.L.B.M. forces appears to be the most pressing task for S.A.L.T.

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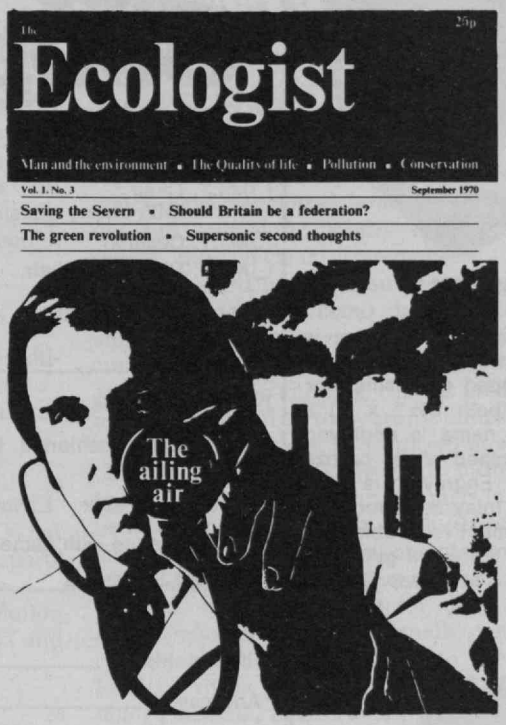

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Trend of Affairs

Trends This Month

MATERIALS

Mending a Broken Ecocycle

In nature, the plant kingdom provides nutrients for animals, and animal waste products are converted into nutrients for plant life. Hitherto, human societies which have developed both crop-farming and animal husbandry have preserved this efficient arrangement. (A medieval word for the manual work of tilling the soil has come down to us almost unchanged: manure.) But in our day it has been found that animal and crop farming can be made more economical if they are optimized separately. Fields can be fertilized more cheaply and controllably with industrially-produced inorganics; animals can be fed more cheaply in high-density lots, sited on the basis of climate and ease of transportation. One result is that the U.S. now has no use for the 1.7 billion tons of manure annually generated—which therefore tends to overfertilize rivers and lakes (see *Technology Review*, April 1971, pp. 48-53). This breakage of a major ecological link, though brought about economically, is not generally regarded as economically reversible. So the search is on for ways of disposing of animal wastes.

At the Pittsburgh Energy Research Center of the Bureau of Mines, it has been found that agricultural wastes containing cellulose can be converted into a heavy fuel oil by heating under pressure with carbon monoxide or hydrogen. For manure, the appropriate conditions are about 350°C. and 4,000 lb./sq.in. Herbert R. Appell told the American Chemical Society this summer that "although manures are in some respects a desirable feedstock for conversion to oil—homogeneous, available in large supply—the high nitrogen content, the high ash content, and the malodorous aqueous effluent pose problems for further research." Of the manufacture of fuel oils from agricultural wastes in general, Dr. Appell remarked that the biggest obstacle is the capital cost of high-pressure equipment: "The next research emphasis will be on ways of converting cellulose to oil at lower pressures, and a search for ways of cutting process costs so that the process will become economically attractive."

Another group at the Pittsburgh Energy Research Center is using a process consisting, more simply, of heating to a few hundred degrees in the absence of air. Whereas Dr. Appell's work started out with lignite as the raw material, later shifting to agricultural wastes, the "pyrolysis" method developed out of a search for a means of disposing of scrap tires. Heating dried cow manure at 900°C. results in—per ton—about 14,000 cu. ft. of gas with a heating value of 450 Btu./cu.ft., 13 gallons of tar and oil, and 726 lb. of "ash." The latter is combustible, and has the interesting property of a heating value slightly higher than that of the raw material (7,300 Btu./lb. as against 7,100), and, unlike the original dried manure, its low content of volatiles "would indicate that the residue could be burned without excessive smoke emission," according to a paper presented at the American Chemical Society meeting. The paper (by M. D. Schlesinger, D. E. Wolfson and W. S. Sanner) did not suggest that the pyrolysis of manure, or of other agricultural wastes, produces a net gain in useful fuel: merely that this is a nonpolluting disposal method which provides for its own energy needs.

But it may yet be possible to return to a closed-loop system, like the natural one. If crop-growing is no longer an economical use of manure, perhaps some substitute can be found for it: some other way of turning animal wastes into animal feed. One of the most advanced of the current attempts at doing this is a bacterial process developed at the Hamilton Standard division of United Aircraft (Windsor Locks, Conn.). This anaerobic process—similar to existing biological treatment systems for municipal sewage,

but potentially far more compact—produces a microbial cattle-feed ingredient of which "the amino-acid quantity and quality compare very favorably with soybean and cottonseed meal, which it can replace in a standard diet." Thus said Hamilton Standard's Warren B. Coe at the A.C.S. meeting. He believes that feedlot operators are likely to be more receptive to such a scheme (offering economies in feed, a major budget item) than to any idea presented to them as waste-disposal, which they are reluctant to admit is their problem. The process also generates enough methane to be self-sufficient as regards power requirements.—*F.W.*

Rottable Plastics

Two forms of self-destructive plastics are now commercially available. Their originators—Dr. Gerald Scott of the University of Aston in Birmingham, England, and Dr. James Guillet of the University of Toronto, Canada—became the focus of a large and intense audience-debate at the national meeting of the American Chemical Society in New York late this summer. It turns out that both these researchers formerly worked on making polymers more enduring, and that the development of plastics which decompose at a rapid and controllable rate has merely been awaiting adequate market demand.

Dr. Scott's system is to mix into the polymer (typically, a polyethylene) a fraction of one per cent of a metallic dithiocarbamate. Compounds of this kind have previously been used to inhibit the degradation of polymers in sunlight, but some of them, at certain concentrations, have the opposite effect; and there is a range of concentrations at which the additive begins to assist in the breakdown of the polymer only after a certain initial exposure to light.

This is, of course, exactly what is required—a packaging plastic which holds together perfectly until it has been outdoors for a few weeks, whereupon it slowly oxidizes and crumbles to powder. The light wavelengths which cause these chemical changes are present in sunlight but do not penetrate glass windows. Dr. Scott believes that one further refinement should be possible: a warning, printed in photosensitive dye, which becomes legible shortly before the onset of degradation. His present system is being used by a Finnish company in the manufacture of carrier bags for sale in U.K. supermarkets.

An alternative system is, instead of using an additive, to modify the polymer itself so that it is sensitive to light. Dr. Guillet does this by incorporating ketones (which contain the group C:O) into the polymer chains. On exposure to direct sunlight the polymer chains break apart at the ketones. Dr. Guillet has used this principle in the manufacture of expanded-polystyrene cups which erode away completely in two or three weeks in the open air, forming degradation products resembling those of natural biological materials. He claims that the process works for all plastics except polyvinyl chloride (P.V.C.), whose chains cross-link together instead of coming apart. (Dr. Scott comments that it might not be wise to make P.V.C. degradable, anyway, since the degradation products would resemble D.D.T.-type pesticides.)

The central aim of both these efforts is to eliminate the plastic litter which at present remains lying around the countryside and waterways indefinitely. Incidentally, Dr. Scott's studies of plastic litter show that, in Britain at least, the general public has been unfairly blamed in this connection: most of the litter is of industrial origin.—*F.W.*

Operation	*Total energy, B.t.u.'s per gallon*	
	Returnable	*Throwaway*
Material acquisition		
30 per cent recycle	693	3,636
100 per cent new	990	5,195
Transportation of raw materials		
30 per cent recycle	69	360
100 per cent new	124	650
Container manufacture	7,738	40,624
Crown manufacture	1,935	1,935
Transportation to bottler	361	1,895
Bottling	6,100	6,100
Transportation	1,880	1,235
Retailer and consumer collection	89	468
Separation, sorting, return for processing		
30 per cent recycle	1,102	5,782
Total system energy:		
With recycle	19,970	62,035
Without recycle	19,220	58,100

Putting soft drinks in returnable bottles rather than in throwaways turns out to cost only one-third to one-fourth as much energy—an advantage we ignore now because energy is cheap. Dr. Bruce Hannon computes what energy is needed for each step of the making and filling of a bottle, assuming that each 16-oz returnable bottle is used eight times. He calculates the figures in two ways: if the bottle enters a reclamation process (with a 30% efficiency) after it is discarded and if it does not.

Refill Those Bottles And Save?

Shall we reuse pop bottles, or recycle them, or throw them away when empty? The practical questions, like this one, of how we can better care for our environment, so far find more emotional than quantitative answers. But two attempts at adding up the costs of each sort of disposal have been made—one by Ben Branch, a Dartmouth economist, and one by Bruce Hannon, of the Center for Advanced Computation at the University of Illinois.

Dr. Branch studied the costs of collecting and reusing beverage bottles and cans in Vermont. Some 70 million nonreturnable bottles and 80 million cans are sold in the state each year, he writes; that amounts to 19,500 tons of trash. At $15 per ton, disposal costs some $292,500 per year.

If we assume, he says, that all nonreturnables be replaced by returnable bottles and that one-fifth of the returnable bottles be discarded with each cycle of use, disposal would cost one-fifth of that sum; so the total disposal savings to be hoped for are $235,000. He also figures that the state and private land-owners now spend $391,500 picking up the bottles and cans that people carelessly throw about the countryside, and he suggests that perhaps the deposit will encourage their saving and redemption.

If the deposit is redeemed, the beverage in the returnable is about one cent cheaper than in throwaways, so some $1.5 million stands to be gained by Vermont consumers.

The total savings might therefore add up to $2,126,500.

But there are costs in using returnables. Dr. Branch estimates the grocers

would spend at least $520,000 in handling the empties. If only one of six bottles is not returned, a five-cent deposit would yield a $1,250,000 loss to consumers. The consumers' time in returning bottles, he estimates, would be worth another $1.5 million. And interest on the money tied up in deposits (at 6 per cent) would amount to $45,000. The total is $2,795,000; the net loss is $669,500.

The change to returnables thus cannot now be justified on economic grounds. So Dr. Branch recommends a one-fourth-cent tax per container on nonreturnables to repay the costs of litter collection and strictly enforced anti-litter laws. Another one-sixth-cent per container would pay for its disposal, but Dr. Branch feels this ought to be levied on all nonrecyclable and nonbiodegradable packages.

Saving More Energy Than Money

Bruce Hannon made his accounting in more detail—and he counted in B.t.u.'s, not in dollars. And, in contrast, he found vast savings in the use of returnables.

He compared the amounts of energy needed to package one gallon of soft drink in returnable and throwaway bottles and in cans: for example, mining the materials for one ton of bottle glass costs 1,979,000 B.t.u.'s of energy. If the glass from the bottles is not reclaimed after they are finally discarded, he figures mining the glass to make the containers for each gallon of beverage costs 990 B.t.u.'s for returnable bottles used for eight fillings and 5,195 B.t.u.'s for throwaways.

He counted up also the energy costs of transporting the raw material to the bottle-maker, transporting the bottles to the bottler, transporting the filled bottles to the distributor, collecting used bottles and taking them to the solid-waste treatment plant (if they are to be recycled as glass cullet) or back to the bottler (if they are to be refilled), for separating and sorting the glass at the reclamation plant, and for returning it to the bottle-maker. (*See the table on the opposite page.*)

It turns out that although re-using containers offers a large energy saving, recycling the returnable 16-oz. bottles for one gallon of soft drink makes only a small difference, and it is in the other direction. Dr. Hannon found the gallon's containers cost 19,970 B.t.u.'s if the glass is recycled and 19,220 if it is not. Throwaway bottles cost 62,035 B.t.u.'s per gallon if they are recycled, and 58,100 B.t.u.'s if they are not. (The calculations allow for the fact that present processes can recover only 30 per cent of the actual waste glass.) For 12-oz. returnable bottles, throwaways, and cans, the energy costs per gallon are 13,895, 46,770, and 52,390 B.t.u.'s, respectively, if their materials are not recycled.

So recycling bottle glass does not save energy, nor, Dr. Hannon pointed out, does it save money. Returnable bottles cost 750 B.t.u.'s per gallon less with no recycled glass; throwaways, 3,965.

"Nongeneration of solid waste is a clearly superior alternative," he said. And then he makes his last revelation: only 3,250 B.t.u.'s are required to prepare a gallon of a soft drink, without the bottles and cans. The gallon contains, as food, only 6,100 B.t.u.'s of energy. "Not even the best existing bottling system would survive in a subsistence society," he concludes. But if we insist on bottling and shipping beverages, he asked, can the popular word "recycle" be changed to the word "refill"?—*J.K.*

Materials for Power

Perhaps more than any thing else, materials are the Achilles heel of the energy business. Without new, specialty materials, there simply is no way out of a future of energy scarcity. This is for two reasons:

☐ Even modest increases in the efficiency with which power is generated can make fuels go considerably farther in conventional systems. Such increases appear to hinge on new materials with new properties. Indeed, said Robert A. Bell, Director of Research for Consolidated Edison Co., at a materials policy forum at M.I.T. this summer (*see below*), "virtually any piece of power equipment could be improved if better materials were available."

☐ Almost without exception, new technologies which can be proposed, or even imagined, to provide new power and better transmission of it depend on specific materials properties—including some not yet approached.

Turbines and Generators

The maximum capacity of permanent magnets has been increasing at a linear rate since 1860 as new materials have been found and used. New developments, including the use of cobalt and rare earths in magnet construction, promise that this rate of progress toward more efficient generators can continue. Indeed, Robert H. Pry of the General Electric Research and Development Center told the forum, today's permanent magnets can be more than twice as powerful as those known only two years ago, and "materials now being explored" hold promise of another doubling in the next two years. The result is that on the basis of these developments alone U.S. cobalt consumption could double by 1980. Will there be enough?

Turbines to drive generators present more serious materials problems. The way to higher efficiency is through higher temperatures; today's maximum for turbine materials is about 1800°F.; "dramatic efficiency gains" could be achieved with 2000°F. materials, said Mr. Fry. True, metallurgical advances have been moving at a rate to increase operating temperatures about 30°F. a year, but this statement hides a multitude of frustrations. As one nears limits, problems grow stubborn.

An example cited by Elihu F. Bradley of Pratt and Whitney Aircraft Co.: when titanium alloys were first used for fan disks in turbine engines, the result was 13 per cent lower fuel consumption and 18 per cent lower weight. Recent development of composites can improve fuel consumption 1 per cent and lower weight by 4 per cent. Under these conditions of low return, said Mr. Bradley, industry simply cannot justify large investments in research. Yet the need for better materials remains.

Reactors and MHD Power

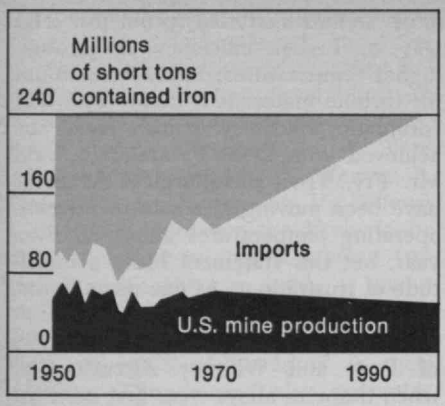
Nuclear power brings up a whole new range of materials problems, many of them based on the need for immunity to radiation.

If the liquid-metal fast breeder reactor can be achieved, its demand for high-alloy and stainless steel will be very great—at least 2,000 tons, involving 360 to 500 tons of chromium, for a large-scale commercial plant, said Arden L. Bement, Professor of Nuclear Materials at M.I.T.

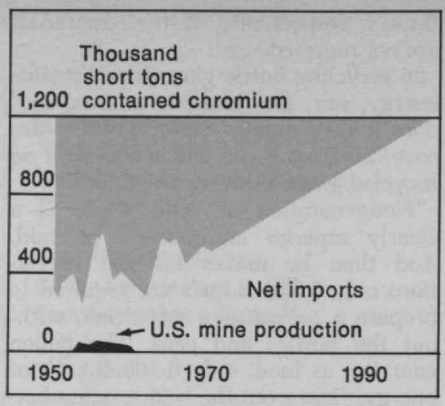
"Chromium for stainless steel is a critical commodity," he said, and it will be "a prominent issue" in any future national materials policy because the U.S. is almost totally dependent on imports of chromite ores. Much of the chromium would be used in association with nuclear fuels, and so the chromium would in fact be expended as power was generated because its radioactivity would make recovery from spent fuel assemblies impossible.

Open-cycle magnetohydrodynamic power systems—if they prove feasible—will require exotic refractory oxides, high-chromium steel, and perhaps up to several kilograms of platinum each. Fusion reactors would require many of these materials—and also niobium, zirconium, lithium, beryllium, and tungsten.

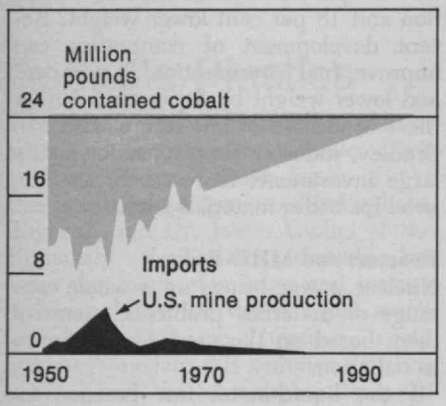
To capitalize on the savings promised by superconductive generators and power transmission systems would require a reliable supply of helium, and Professor Bement believes that helium demand for these purposes over the next 30 years "will very likely cause significant discontinuities in both availability and cost." Indeed, he told the forum, "dwindling helium reserves could foreclose on important future applications of superconductivity."—*J.M.*



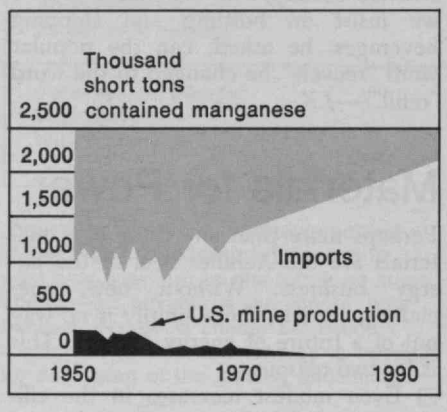
Iron



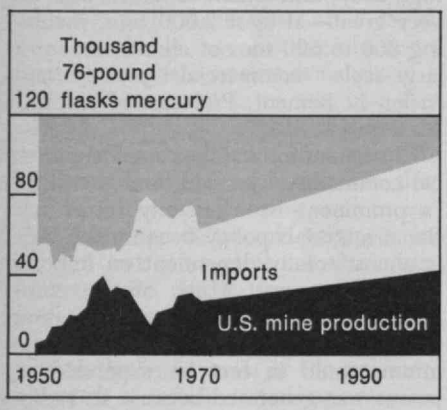
Chromium



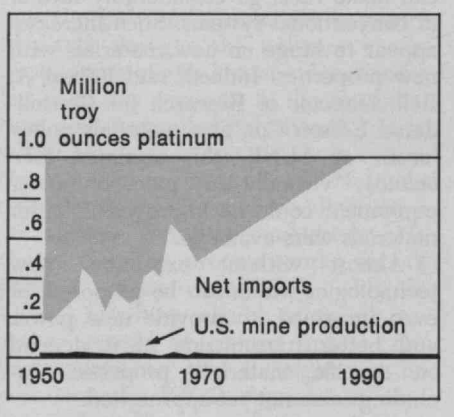
Cobalt



Manganese



Mercury



Platinum

Summaries and projections by the National Commission on Materials Policy make "clearly evident," says the Commission, that "the gap between U.S. requirements and the remaining easily accessible world supplies (of minerals) is widening." Before World War II, the U.S. was in general a net exporter of minerals; since then imports have far exceeded exports. In 1970 imports of all minerals were valued at some $9 billion and exports at $5 billion—a net deficit of about $4 billion. By the year 2000, says the Commission, that deficit could be as high as $60 billion a year. The decreasing size of the shaded area in each chart reveals the growing U.S. demand.

Materials Policies?

So if we run out of niobium, zirconium, tellurium, columbium, even helium: what then?

For the next 50 years we can probably be fairly confident in giving either one of two simple answers: we really have enough; or we can find something else. But as technology becomes more complex and its materials more exotic, our supplies and our alternatives will diminish. Though estimates of supplies and costs for the year 2000 are "not really alarming," says Dr. Earl Hayes, Chief Scientist of the U.S. Bureau of Mines, "when you reach for 2040, then you've got real problems."

Sensing issues of this kind, the U.S. Congress in 1970 established a National Commission on Materials Policy, and by 1972 the Commission has:

☐ Assembled some impressively gloomy data on U.S. supplies and consumption of a wide range of mineral materials (*see charts*).

☐ Organized a series of forums on principal university campuses, seeking views on such issues as raw material supplies, shortages and surpluses, new materials and energy needs, transferability of demands, and technological prospects—all the issues which would come together in a national materials policy, if indeed one can be devised.

It was at the M.I.T. forum early in the summer that Dr. Hayes took his dim view of our materials situation 70 years hence—and even of our ability to make prognostications about it. As an example of the difficulty, consider the simple flash bulb. Zirconium powder was the standard photographic illuminator in the 1920s. Then came aluminum foil in vacuum bulbs, then back to zirconium, of which some 90 tons were used in 1971.

Now suddenly hafnium turns out to be the best illuminator of all: it produces over twice as much light as the same quantity of zirconium and five times the light of aluminum, and it requires no filter for color correction. One pound of hafnium makes 11,000 flash bulbs, and already one ton of hafnium has been irretrievably vaporized by eager picture-takers.

But hafnium is also uniquely useful for naval reactor control rods. As the flash-bulb market switches from zirconium to hafnium, will there be enough? For a while.

Another example: there is suddenly a lively market for europium, one of the rare earths, because it is the best ingredient to produce the red radiation in a color television tube. This demand, unimagined ten years ago, now accounts for 20 per cent (dollar value) of the rare earth market. Will we run out? Probably not, since the "rare earths" are in fact far from rare.—*J.M.*

ENERGY

Fresh Woods, and Outfalls New

The uninhibited schemes of the solar-energy proponents would seem to have stimulated the imaginations of their more conventional rivals, to judge from two contributions to the 7th Intersociety Energy Conversion Engineering Conference, held this fall in San Diego.

One type of solar power plant would cover a large area of land with semiconductors. If this is conceivable, reasons George Szego of InterTechnology Corporation (Warrenton, Va.), is it not equally conceivable that a similar area could be covered with trees, which would be burned in an ordinary power station in place of fossil fuel? Unlike fossil fuel, wood is renewable, and its ash can be used as a fertilizer. Dr. Szego finds that, depending on local conditions, wood could cost anywhere from 3 c./million Btu. to 46, the latter figure being close to present costs of fossil fuel. For a steady 1000 MW of electric power, the plantation would be between 110 and 630 sq.mi. in area. It could of course be used for other purposes at the same time: "recreation, water retention, erosion reduction, wildlife conservation, etc."

(Another role for forests emerged at the American Chemical Society Meeting in New York this summer. The usefulness of compost made from municipal solid waste has been examined in relation to both agricultural crop land (by a group at the Tennessee Valley Authority's National Fertilizer Development Center) and to forest (at the University of Florida's School of Forest Resources and Conservation). Both groups reported excellent effects on growth, but forest appeared to have a number of advantages: wood is not used as food; the cycle of tree planting and harvesting takes long enough to allow slow-decomposing substances to be assimilated; up to 200 tons/acre of urban-waste compost can be spread safely prior to tree planting, whereas the T.V.A. group found that, at 146 tons/acre over a two-year period, soil zinc concentrations approached levels that could be toxic to some farm crops. So perhaps a city's "energy plantation" could also absorb its garbage.)

Another proposed type of solar power station (currently the subject of a $200,000 N.A.S.A. study contact) is the orbiting microwave transmitter, which would obtain its power from solar cells and transmit a beam of radio energy to a few square miles of antennae on earth. Dr. J. Richard Williams and three colleagues at the Georgia Institute of Technology find that if it is feasible to beam from orbit to earth an energy supply obtained from collecting solar radiation, it is even more feasible when the energy is nuclear in origin. An orbiting nuclear power station would not release fission products to earth; it would put them into a solar orbit inside our own. (The U.S. Atomic Energy Authority still appears to be taking fairly seriously the idea of disposing of nuclear wastes by rocket; the natural next step might indeed be to remove the nuclear power station from the earth's surface to begin with.) The Georgia orbiting atomic power plant would be of an original kind: remotely controlled, with a magnetohydrodynamic high-temperature generation stage, and gas-cored.—*F.W.*

Electric Home Heat Is Cleaner?

Early this summer Westinghouse publicized the fact that the electric heat product manager of its Bryant division had spoken thus at an industry seminar on electric heating:

"One thing is clear and you can tell it to your customers. The scientific evidence is now in and it's in our favor. It shows that electric residential heating is one of the keys to a cleaner environment. Not only does electric heating result in less pollution of the air we breathe, but it conserves our natural resources to boot!"

The announcement explained that the "scientific evidence" in question came from a study by the New York firm of Gordian Associates, comparing "the effect on the 1980 environment of 100 per cent electric residential heating versus the effect of all-fossil-fuel heating." The study, prepared for and published by the Electric Energy Association ($5.00), "showed that the resulting total amount of pollutant particulates in ground-level air—the air we breathe—would average 70 times greater with all-fossil-fuel home heating," said Westinghouse.

One operative phrase is "ground-level." The factor of 70 is what remains when the actual relative emissions of the two methods of heat generation—which come out in favor of domestic furnaces—are adjusted by a factor of 100. This factor is derived from the average effective heights of power station smoke-stacks and of residential flue-vents, using Sutton's Equation, which (to put it simply) says that the maximum intensity of pollution delivered to ground level by an elevated source is inversely proportional to the square of the effective height of the source. ("Effective" means the height to which the smoke rises shortly after leaving the source.) The report states that the factor of 100 is merely an order of magnitude.

Another operative phrase is "the 1980 environment." The primary reason for choosing this date was apparently that, by then, "pollutant emission reductions now being proposed and implemented by federal, state and local regulations will be largely achieved." So the conclusions do not by any means apply to today's power plants.

But there is another consequence of choosing a date in the middle-future. The heating of homes by electricity is treated in the analysis as a completely new national electricity demand, for which new generation capacity would have to be installed. It is assumed that this new capacity would be a mixture of fossil and nuclear, in the proportions that are currently projected by the Federal Power Commission for the coming decade's new installations: 60 per cent nuclear, 40 per cent fossil. The emissions from burning fossil fuels in homes to produce heat are then compared with those from an equivalent electrical capacity of which only 40 per cent is fossil-fueled and thus contributes to particulate or chemical pollution. Roughly speaking, this 40 per cent compensates for the inefficiency inherent in the generation of the electricity, and brings the two methods to an approximate break-even.

If we return to the present, and consider the pollution generated in supplying electricity to existing home-heating systems from today's mix of power stations (almost entirely fossil) this 40 per cent factor disappears—heating homes with electricity obtained at an efficiency of 30 to 40 per cent is wasteful. The same applies to the notion that electric heating "conserves our national fuel resources." Any use of electricity conserves our (fossil) fuel resources if the electricity is mainly from non-fossil power stations.—*F.W.*

TRANSPORTATION

The Progressive Balloon

The most efficient aircraft in terms of passenger-miles per gallon, according to the recent transport energy survey by Professor Richard A. Rice of Carnegie-Mellon (*see* Technology Review *for January, 1972, pp. 31-37*) would be a proposed helium-filled dirigible. His figure—44 pass.-mi./gal.—is for a 275-gross-ton airship, 370 feet in length, with a 200-ton payload. The design figure for seat-miles per gallon (80) is twice that of the 747 and slightly greater than that of the Metro-

liner train.

Last November, an editorial in *Aviation Week* noting that "lighter-than-air has faded from any operational role" drew a correspondence-page controversy that continued well into the summer. The argument eventually focussed on the question of the relative structural merits of the traditional Zeppelin-type fabric-covered framework and the more recent all-metal monocoque. Either way, modern materials and control methods would ensure that tomorrow's dirigibles would be radically better than those of the past. A former director of the Guggenheim Airship Institute wrote: "The airship engineers of the 1920s did not try to solve transportation problems with Civil War vintage balloons, and we should not use 50-year-old airships. We should show the same courage they did."

Dirigibles were used by the U.S. Navy in anti-submarine exercises until the 1950s. The Air Force Cambridge Research Laboratories' Balloon Research Branch is currently investigating the use of small unmanned dirigibles to "extend Air Force capabilities in a number of electronic fields, while operating within Free World boundaries." But it is the non-dirigible that holds the field at present, for research, meteorology and pleasure-flying. Goodyear Aerospace Corporation is currently (*Aviation Week*, Feb. 14, 1972, p. 24) examining the feasibility of fitting space-shuttle boosters with hot-air balloons. The idea is that the returning booster, having been slowed down by parachutes, would warm up a cluster of balloons and lower a sea-anchor, thus coming to a complete halt a short distance above the ocean while a retrieval barge hove-to underneath.

So the achievements of the brothers Montgolfier and Professor Charles (1783) live on; that of Count Zeppelin (1900) survives mainly in the form of the three small Goodyear advertising vehicles (a fourth was built by Goodyear this year in Britain); while Ralph H. Upson's monocoque (1929) has been relegated to the drawing board.

But, with energy growing expensive, there seems to be a revival of interest. *Chemical and Engineering News* (June 26, 1972, p. 3) attributing the revival to today's abundance of helium, tells of a German airship engineer who hopes to sell an initial 60-meter-long model (the size of the Goodyear blimps) to France or Japan before moving on to something twice the length carrying 120 tourists. The same periodical (August 14, p. 5) describes some of the plans of a recently formed British company, Aerospace Developments—including a scheme for transporting natural gas in its gaseous form, in airships 1,800 feet long. And at a conference of the American Society of Mechanical Engineers that was held in New Orleans in September, Miles M. Sonstegaard of the University of Arkansas calculated that natural gas could be transported by balloon for a cost of two mills per 100 million cu. ft.-miles, and that the most critical design factor is the cost of the airship's surface. Dr. Sonstegaard's airships would be in the region of a mile long.—*F.W.*

Transport Studies: A Federal Strategy

The Department of Transportation budget for fiscal 1973 is in excess of $8 billion; about $300 million is for research and development, and of this only some $10 million will go to universities. Yet transportation claims about 20 per cent of both the gross national product and the country's natural resources, and as much as 25 per cent of its energy.

Why this small commitment to university research from the agency charged with transportation policy and planning?

Whether a lack of funding bred university disinterest or the other way around is an unanswerable chicken-and-egg problem. But Herbert H. Richardson, M.I.T. Professor of Mechanical Engineering who this fall returned to the Institute after two years as Chief Scientist at D.O.T., suspects that D.O.T. people have not understood "the potential value of the techniques of management and planning that the university could make available."

When he went to Washington, Professor Richardson discovered that D.O.T. itself typically made decisions on what should be studied and then requested specific proposals. With support only on this basis, the universities could not plan and set up broad capabilities in transportation research. And D.O.T. had only primitive mechanisms to inform researchers about what kinds of work were being sought. Those who wanted to "convert" from military to civilian problems could not easily find ways to do it.

Professor Richardson thinks one of his principal contributions at D.O.T. was a plan for broader funding of university research on transportation. He proposed a general research fund giving preference to "unusually innovative projects", "younger unestablished faculty members", and "faculty members who are reorienting research efforts toward transportation". Typical projects would be small ones, on which some form of matching funds might be available from industry or local government.

"The university offers a broad base of knowledge for interdisciplinary and innovative approaches to transportation problems in a relatively unbiased atmosphere," Professor Richardson wrote in a working paper. "Here the best talent (mature and young) meet through the coupling of research and training, thereby providing research results, development of human resources, and an upgrading of the overall national competence."

The proposal survived its passage through Congress and emerged with $4 million for 1972-73.

Other issues which occupied Professor Richardson's time as Chief Scientist at D.O.T.:

☐ Urban transportation by magnetic levitation of vehicles, by tracked air-cushion vehicles, or by privately-owned vehicles which could also be used on automated guideways.

☐ The erosion of pipelines by anaerobic bacteria.

☐ The detection of molecules typically found in explosives by means of gas chromatography or the luminescence of bacteria—this being of immediate importance in programs to detect would-be aircraft hijackers.—*M.F.*

City Wheels

The Pasadena Freeway began as a bicycle path, four lanes wide. The League of American Wheelmen was founded before the American Automobile Association. And bicycle makers developed the techniques of mass production that were Ford's basis. Ford, like Charles and Frank Duryea and the Wright Brothers, was a bicycle mechanic.

Now, as the automobile's greater complexity—in size, mechanics, use of energy and space—makes it often difficult and unpleasant to use, the bicycle—itself more complex than it was—is again a widely used kind of adult transport. So the California Legislature commissioned the Institute of Transportation and Traffic Engineering (at the University of California-Los Angeles) to study what provisions are and ought to be made for its use in cities. I.T.T.E. reports on:

☐ How wide a bikeway lane ought to be: 3.3 ft. (1 meter) is the usually accepted, German standard. Two lanes in the same direction need 6.4 ft. The vertical clearance ought to be 8.2 ft., and the bikeway ought to be physically separated from automobile traffic and from pedestrians.

☐ How many lanes a bikeway ought to have: one lane for both directions of travel is not satisfactory, as the lane is

wide enough for only one set of handlebars. One lane one way can carry, according to European and Asian studies, about 2000 cyclists per hour; two lanes one-way can carry 3000 to 5000, and four lanes two-way can carry 5000 to 10,000. (Densities for automobiles, on their much wider lanes, are not much greater.)

☐ What the maximum permissible grade is: 3 to 5 per cent.

☐ What the best turning radius is: the average speed on a several-geared bike is about 10 mph., implying that the turning radius with which cyclists should feel comfortable is 13.9 ft.

☐ How much a new bikeway will cost: for construction, $8000 per mile for two lanes and double that for four. Rights-of-way, signing, preparation of the course, lighting, landscaping, and other incidentals, of course, will cost more.

☐ What the best construction material is: something like two inches of asphalt over three inches of gravel, and the asphalt can be a regular highway mix if it is dense and fine. (But, the bruised cyclist pleads, the surface must be *very* smooth.)

☐ Where a bikeway can be built: railroad (unused) and power rights-of-way are good (often grade-separated) paths through a city that might be available. Bikeways can be located in the outer traffic lane on city streets, on levees, along flood-control channels, on part of the sidewalk, several feet in from the sidewalk, in their own lanes physically separated from motor traffic on city streets, or in other places—each choice depending on the numbers of bike, auto, and foot users the route has.

☐ What bicyclists appreciate in a good bikeway: a view. Preferably a pretty one, of natural features or of historic places. A route that lets them ride to work or visit friends or shop or just ride because the ride is pleasant. A route that connects to other routes.

☐ How serious cities really are about bikeways: Davis, California, for one, is. Davis has 18,000 bicycles (and 24,000 people) and requires new housing construction to provide for bikeways.

So is the State of Wisconsin, which has a 300-mile system that accommodates a week-long cycle trip through a very pretty state. Stevenage, England, a new town near London, provides a grade separated bikeway at intersections. It runs, in places, along ancient country routes that are reserved for cyclists and pedestrians. And Dade County, Florida, has some 100 miles of marked routes. Ohio has at least seven scenic routes of 25 to 50 miles throughout the state. And Marin County, California, has finally provided a path for non-motorized egress from Sausalito, one that connects to a 24-mile system that includes 6 miles of separated bike trails and that in turn connects—by ferry—to the bike route system of San Francisco.—*J.K.*

Poor Man's Platinum

The present world production of platinum is about a million ounces a year. The Engelhard catalyst unit which currently seems the best bet for removing carbon monoxide from automobile exhausts contains about a tenth of an ounce of platinum; which means that, if it comes into general use, Detroit alone will abruptly double the world demand for this metal. Known platinum reserves in South Africa are about 200 million ounces; the other major source is the U.S.S.R.

Nobellist Willard F. Libby, of the University of California (Berkeley), considers the need for some alternative to platinum sufficiently serious to warrant an international crash program of research, with the industrial-secrecy wraps off so that the developers and users of proposed catalysts can freely share analyses and know-how.

Dr. Libby's part in the investigation of one possible "poor man's platinum" (lanthanum cobaltite) was indicated in this column in October (p. 56). Late this summer he reported to the New York Academy of Sciences that lanthanum cobaltite's ability to oxidize carbon monoxide has in fact been tested on a real automobile, by a researcher at the University of California (L.A.) School of Engineering, with apparent success; and that the same compound, in reducing conditions, catalyzes the conversion of nitrogen oxides to ammonia. But the cobaltite cannot yet be fabricated into an effective, reasonably compact converter; the commercial platinum unit also still leads on endurance.

"I think platinum has the best chance in the short run," said Dr. Libby; but he sees "every indication of eventual success" in the search for an alternative catalyst. The biggest obstacle to this success, he thinks, is the habit of industrial secrecy. Neither should "pride of ownership" impede us, he added; an intermediate step toward the cheap auto-exhaust converter might be a unit containing both platinum and one of the new rare-earth-oxide materials. The latter, being solid semiconductors, could be heated electrically during the cold start-up period.—*F.W.*

Arguing About Auto Emissions

Air pollution is regional, and that complicates a problem whose management is already difficult. That it varies so—from, say, Eagle River, Wisconsin, to New York City—is one reason the Ad Hoc Committee on the Cumulative Regulatory Effects on the Cost of Automotive Transportation (R.E.C.A.T.) reported last spring to the Office of Science and Technology that the one national air pollution control law, the Clean Air Act and its amendments, was infelicitously conceived and precipitously passed.

The committee feels that the motorist in a place like Eagle River does not need and should not pay for the emission controls that the motorist in a place like Manhattan needs. And it is not convinced that in general the costs of control are justified.

Fulfilling the 1975 and 1976 standards for auto emissions will cost, over the next decade, far more than the damages from those emissions would have, the R.E.C.A.T. committee decided. The committee (comprising government and industry people) does not specify what counted in their estimates of damages, but one of their sources (presented in an appendix) says it could not quantify "soiling costs, animal losses, aesthetic costs, and litigation." The source does count "health costs, materials damages, property devaluations, and vegetation damage."

During the decade of replacement, at the end of which—1985—all cars in the U.S. would meet the 1976 standards, the committee believes $95 billion would be spent on installing and maintaining the control equipment; it figures their benefits to be worth only $18.3 to $46.3 billion.

The committee faults the stringent NO_x requirement. Relaxing it from 0.4 g. per mile to 1 or 2 g. per mile would not harm "materially" the effort for better air quality "in many regions," it says, and would decrease substantially the costs of controlling emissions. (It records no estimate of the savings.) Stationary emitters produce about as much NO_x as mobile ones, the report says, but face controls both less expensive per ton of NO_x not emitted) and less severe (their maximum is nowhere near the decrease of 90 per cent of 1970 emissions required for automobiles.) The committee feels that stricter controls for stationary sources like power plants might more efficiently reduce the NO_x in the air—or at least that controls ought to be flexible from one region to another.

The report estimated the changes in NO_x emissions in the New Jersey-New York-Connecticut air quality region for three decades, given a requirement for 1976 and after of either 0.4 gm. per mile or 1.25 gm. per mile: such gains as either requirement produces are overwhelmed by the emissions from stationary sources. By contrast mobile sources are responsible for more than

two-thirds of the NO_x emitted in Los Angeles, and implementing the controls on mobile sources will bring their emissions to about two-thirds of the stationary contribution, which will remain about the same.

Photochemical smog requires several components, and because conditions vary the report suggests that a given area might find most suitable a strategy aiming to control just one component. As Victor McElheny explained in his column for July/August, for that reason, among others, California air quality administrators also seek more regional control.

But California disagrees with the R.E.C.A.T. report in that it wishes to come down harder on NO_x and to ease up on the carbon monoxide and hydrocarbon requirements—since California's biggest air pollution problem is photochemical smog and nitrogen oxides are crucial to its making.

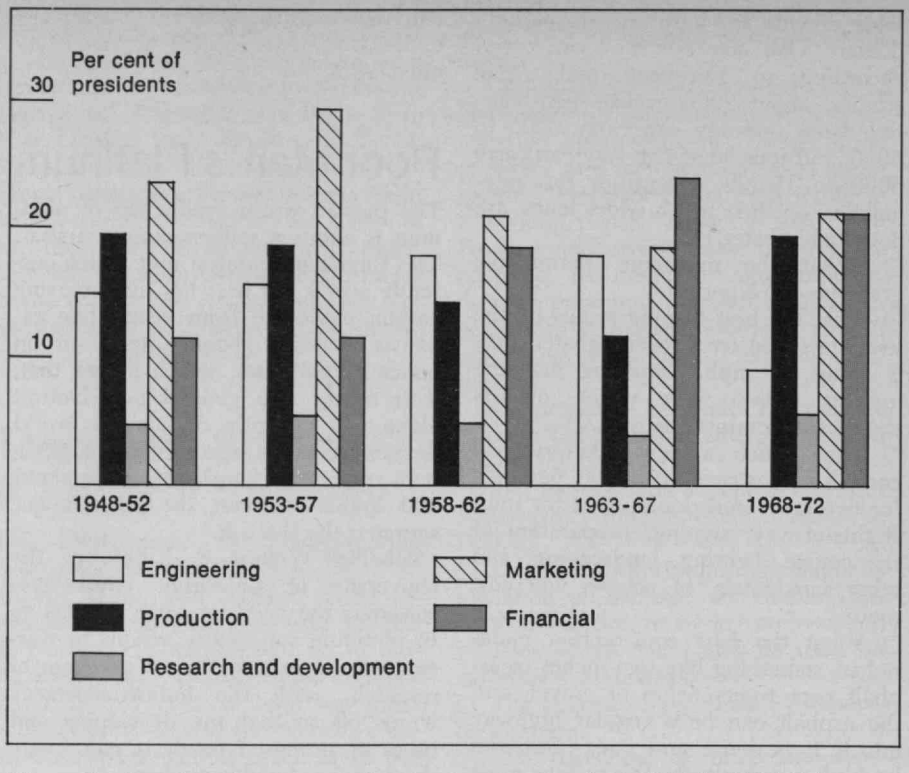
The R.E.C.A.T. group questions whether the standards for air quality can be met at all in large cities, finding that, even if the proposed standards of a 50 per cent reduction of CO from existing sources and a 90 per cent control for new sources are met by 1977—together with the 1975 1.7 grams per mile standard for mobile sources—achieving the ambient level of CO required by the E.P.A. could be done only by imposing controls on the movement of traffic. The same difficulty will be found for NO_x and hydrocarbons in various areas.

Surveying the possibilities for mechanical controls, the R.E.C.A.T. committee recommends: "Regulation should not be based on a blind faith in technology. Establishing standards beyond the known state of the art on the theory that industry can do anything if enough pressure is put on it is not likely to result in wise governmental decision making or to produce the greatest net benefits to society."

In addition, it questions whether the demands for 1976 do not divert money and effort into revising the internal combustion engine that might be better invested in developing other types of engines, and if the insistence on 1975/1976 falls outside the normal time scale of changes in automobiles and therefore causes great and unnecessary cost to the consumer of automobiles and gasoline.

Further, the committee wonders, since more than 30 per cent of the population lives outside large metropolitan areas, and since we can assume that the air quality in these regions is good, why order these persons to buy emission control equipment they do not need? It believes a two—or more—car strategy might better serve the nation, with each region permitted to specify the equipment on autos registered there that supplies the level of control it feels it needs. The E.P.A. calculates control equipment for each car will cost $350; some of the controls—especially for that 0.4 gm. NO_x requirement—will decrease mileage per gallon of gas. The committee quotes a range of 10 to 35 per cent fewer miles per gallon if the 1975/1976 standards are met.

Safety equipment, which the R.E.C.A.T. committee also studied, will cost even more. Gadgets including the air bag, the only type of passive restraint near readiness (and it is not ready), and stronger bumpers, primarily, account for a cost increase of $523—the committee feels that using lap and torso belts is just as effective, and that those who choose this method are heavily penalized if they are required also to purchase a passive system. And, as transport expert Martin Wohl has suggested (*Technology Review*, July/Aug., 1969, pp. 72-3) people should arguably be permitted to choose their own levels of risk—*J.K.*



When directors look for new presidents, they head for the field which the company needs most to emphasize, says Henry O. Golightly, management counsel. So it was that engineers were chosen by 18 per cent of the 100 largest U.S. companies from 1958 to 1967. But then came their downfall—to 8 per cent in 1968 and 1969—while production and marketing became the sources of the action.

MANAGEMENT

Up the Engineers

In the decade from 1958 to 1967, 18 per cent of the men chosen as presidents of the 100 largest U.S. companies were engineers. But engineers were only 8 per cent of the presidents chosen or serving in 1968 and 1969, and 11 per cent in 1970 and 1971. On the rise, instead, were presidents with backgrounds in marketing and production.

Men with research and development backgrounds have taken 4 to 6 per cent of company presidencies consistently since 1948.

These figures come from a survey series—of which the last four-year installment is just completed—by Golightly and Co. International, Inc., a New-York-based management consulting firm. Their interest derives from Henry O. Golightly's assumption that the kinds of presidents companies choose reflect changes in corporate emphases. After World War II, he thinks, financial men had top billing because mergers, acquisitions, and capital problems were at the top of many agendas. Now companies are emphasizing lower costs and higher sales—hence the call for production and marketing men.

But one paradox: In the current survey (1968-1971), 34 of the 100 companies elected as president a man whose background was different from that of his predecessor. Five of these companies—15 per cent—turned to engineers. This fact, and the slightly growing (though small) number of engineers chosen in the same period, suggests to Mr. Golightly that "certain

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kinds of engineering talent"—notably automation and pollution control—are growing in importance.—*J.M.*

Creative Hassle

Do engineers work better under pressure, or is there really something to the old idea that the supposedly unhurried academic environment breeds creativity in research and development?

The question is not original, and there is a contradictory body of folklore on the subject. Here is a new answer, based on a five-year study of an industrial research and development laboratory by Frank M. Andrews and George F. Farris of the Sloan School of Management: Time pressure does in fact enhance several qualities of scientific performance, and high-performing scientists tend to want pressure, not relief from it.

Professors Andrews and Farris studied the effects of time pressure at a N.A.S.A. research laboratory specializing in materials; they took their data in two series, one in 1965 and one in 1970. Their results, published this fall in *Organizational Behavior and Human Performance*, show clearly that scientists and engineers who felt more than average time pressure in 1965 were more than ordinarily productive during the subsequent five years. The reverse was not true; scientists feeling time pressure in 1970 had not necessarily been notably productive in the preceding years.

Scientists who felt little time pressure were generally isolated, little influenced by colleagues, relatively uninvolved in their work and in the administration by which it was managed. Their colleagues who felt pressed to finish all their work were just the opposite: they were good communicators and they took an active interest and/or role in administration. The best performances were turned in by those scientists who wanted pressure—and had it.

Professors Andrews and Farris are cautious. "We would not want to imply that time pressure is the only motivator," they write. But their results "suggest it may be one important source of motivation."—*J.M.*

Territorial Imperative: Optional in the Office

The engineer in his office is like the lion on the veldt; each has his territory, clearly marked off from that of any other of his race. But the four walls of an office are obstacles as well as markers, and—especially if the engineer's job is to work with others—an office may be just what he does not need.

Reasoning thus, Thomas J. Allen and Peter G. Gerstberger of M.I.T.'s Sloan School of Management persuaded the directorate of a technologically based New England company to put its product engineers—as an experiment—into a "nonterritorial" office. They removed walls, desks, and all but one of the "permanent stations" to which engineers might view themselves as attached. And such "personal artifacts" as photographs, books, and certificates were outlawed. Instead, they provided simply a large room with tables, chairs, and laboratory benches and announced that anyone could work wherever he liked—and move from place to place as his mood or his assignment changed.

The one "permanent station" that remained was used by a "central communicator" who handled mail, received visitors, and routed telephone calls. And three other special areas were designated—a computation area housing consoles for computer access; a "partial quiet area," screened by wall and draperies, for meetings and individual work requiring intense concentration; and a conventional conference room for confidential meetings.

Did it work? Professor Allen and Mr. Gerstenberger devised a questionnaire to see how the communications patterns of occupants of the "nonterritorial" office changed—and how they compared with those of engineers with similar assignments in conventional offices at other locations.

First, did its inhabitants like the "nonterritorial" office? Could people adapt to working without some home base that was permanently theirs? Yes; and the longer people worked in it, the better they liked it. Each user felt he had more space than before—and, on the average, more privacy, for the office quickly developed "quiet places" whose users were seen by all others in the office as wanting to be left alone. The general noise level was higher, but not much.

Next, how about the relationship between workers in the department? Intradepartmental communication, report Professor Allen and Mr. Gerstenberger, was more evenly spread through the department—and far heavier. In the conventional office the average engineer had communicated each day with 3.56 different departmental colleagues a total of 8.04 times. In the "nonterritorial" office, average daily communications increased to 11.82 with an average of 6.02 individuals (even though the size of the department decreased during the period of the study because of retirements and transfers).

Was the office's new flexibility really used? Yes. No one spent more than half his time during a typical day at a single table, and the median proportion of time spent at any single table by one individual was less than 10 per cent.

What happened to communication with other departments—the key variable in a product engineering department which mediates between research people and production people? No significant change, after the first three months when the novelty wore off and sightseers stopped coming.

And, finally, how about departmental performance as a whole? No change.

The experimenters are therefore left with unanswered questions: Perhaps improved communication does not in fact correlate with improved performance. Or perhaps eight months is simply too short for better communication to have its effect.—*J.M.*

Maoist Chemistry

Touring the laboratories of a mainland Chinese polymer plant, Herman F. Mark discovered a team working on the synthesis of a polymer used only in certain cryogenic applications. When the retired Dean of the Brooklyn Polytechnic Institute questioned whether such a recondite effort was justified, he was told that the Chinese researchers were finding out how to make such a polymer just in case they ever needed it.

This pattern was repeated a number of times, Dr. Mark told the American Chemical Society this August, a month after his return. He found one group learning how to make polytetrafluoroethylene (Teflon), partly in order to acquire the know-how and partly to avoid China's having to purchase this special-purpose material. Another team was making nylon from soy-bean oil, and was quite unworried by the observation that such a process was uneconomic. The polymer plant itself, in fact, was uneconomic and inefficient by Western standards, because of its abundant use of human labor—but Dr. Mark was impressed by the concomitant gains in control and interrupt capabilities.

The labor-intensive approach was also evident at a small oil refinery employing 10,000 people. Everything that possibly could be was done manually—not through any lack of knowledge of what can be done with electric motors, but by choice. Dr. Mark found this particular refinery odorless and spotlessly clean; refuse did not accumulate; it was removed as soon as produced. The "commune" where the workers lived—Dr. Mark compared it to a Canadian mill-town—was also engaged in agriculture and would apparently not have suffered if the re-

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finery had been closed down for half a year (which, in a centrally controlled country, is a possibility). The oil was transported to the refinery not by pipeline but by train—another labor-intensive option.

It appears that Chinese laboratories are now pretty well reactivated, after the hiatus of the Cultural Revolution. Laboratory equipment generally corresponds to that of 15 to 20 years ago in the West; that is, the Chinese scientists have to get along without our recent time-saving and labor-saving devices. This they apparently find no great disadvantage, both because of the overall labor-intensive style and because of the policy emphasis on a long-term accumulation of know-how, in contrast to quick mission-oriented results.—*F.W.*

Jobs: Engineers Up, Scientists Gloomy

Though M.I.T.'s data are somewhat clouded by incomplete reports from graduates, the local and the national conclusions are identical: 1971-72 was a good year to be an engineering graduate—but a bad one in which to finish in science, especially if you did so with a doctorate.

While 10 per cent of M.I.T.'s science doctorates found jobs in industry in 1970-71, only 7.6 per cent did so in 1971-72, reports Robert K. Weatherall, Director of Placement. Less than 3 per cent reported themselves unemployed a year ago—compared with 4.6 per cent in 1971-72. And more students than ever before elected postdoctoral research or further graduate education.

Meanwhile, says Mr. Weatherall, 1971-72 was "quite a good year" for those graduating with doctorates in engineering, and next year will be even better.

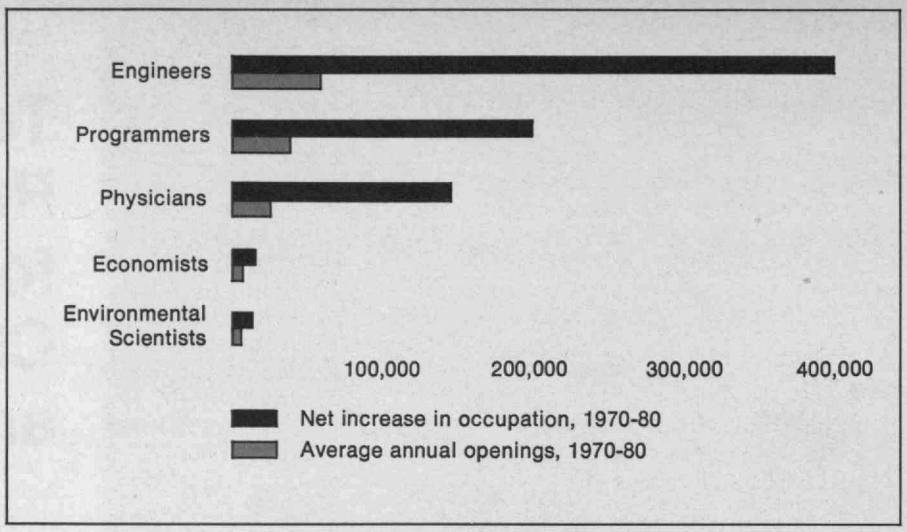
John D. Alden, Director of Manpower Activities for Engineers Joint Council, agrees. Recent reports of high unemployment among engineers have discouraged many students, and engineering enrollments in most universities have fallen in the past five years.

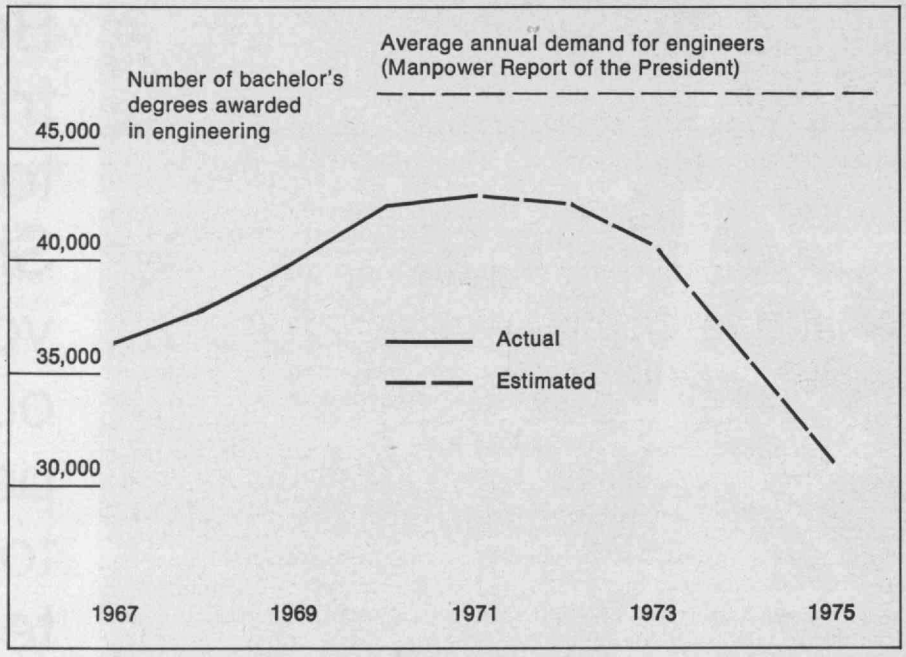
Now, says Mr. Alden in the fall issue of *New Engineer*, the demand for engineers "is picking up, even as the supply of new graduates begins to fall." Indeed, he says, "engineering unemployment is only half the national average," and he expects—as economic recovery grows stronger—that "the existing surplus of unemployed engineers will vanish as suddenly as it materialized."

The U.S. Department of Labor believes that engineering will be an area of high growth in the decade ending in 1980, with an increase of 400,000 professionals in practice in that period. Meanwhile, a study of enrollments convinces Mr. Alden that the number of engineers graduated in the U.S. will be lower each year through 1976—and probably beyond; the result, he says in a new Engineering Manpower Bulletin published late this summer, can only be "a 'seller's market' for engineers in the years ahead."

Already the Deutsch, Shea, and Evans scientist/engineer demand index—calculated on the basis of placement advertising for technical people in newspapers and journals—rose to its highest level in 28 months at the end of July, 1972. Though the absolute demand was "relatively low," D.S. and E. considered that "the employment market for technical people has turned a corner," especially since demand had held up during the usually quiet summer months.

Less optimism prevails for the sciences. Robert K. Neuman, the American Chemical Society's manpower expert, wrote in the *Journal of Commerce* at the time of the Society's annual meeting this fall that, despite some evidence of improvement, "chemical professionals are still facing far from a strong seller's market for their talents." Nor, he said, "can we ever expect to return to the halcyon days of





Engineering will be where the action is in the 1970s, says the Bureau of Labor Statistics. Between 1970 and 1980 the profession will increase by 400,000, with 58,000 new openings per year. No other of the fields surveyed by B.L.S. shows higher demand. Meanwhile, engineering enrollments in U.S. colleges and universities are dropping—and will continue to do so at least through 1975-76, according to the Engineering Manpower Commission of the Engineers Joint Council. At no time will the number of engineering graduates reach the demand projected in the Manpower Report of the President. Increasing demand and decreasing supply will add up to a "seller's market" for engineers in the period, writes John D. Alden, E.M.C. Director.

the early and middle 1960s."

Mr. Neuman's best news was that job openings for college chemistry graduates increased in 1971-72 for the first time in three years. Indeed, he reported for the College Placement Council, hiring in the field of chemicals and drugs is up 52 per cent over last year.

At the same meeting, Carl S. Vestling, Head of the Department of Biochemistry at the University of Iowa, reported a detailed statistical analysis of U.S. biochemists. On the basis of his figures, Dr. Vestling said, to replace attrition in biochemists in U.S. universities alone would require from 250 to 550 doctorate graduates each year.

But the actual number who completed graduate study in 1968 was 573. Dr. Vestling therefore concluded that production of doctorate biochemists may now be "somewhat higher" than the number required for attrition replacement, and he hopes that enrollments can be stabilized at "somewhat below the present level" for a five-year test period.—*J.M.*

COMPUTING

What The Computer Is Really Doing

The chatter of printouts and the gyrations of tape-spools are all it takes to make a computer installation look fairly busy, to the uninitiated. But the central processing unit (C.P.U.) is like the hand of a stage magician: the eye does not see what it is really doing—if anything—at a given instant, but only sees the results, later. If the system is supposed to operate in real time, and there are frequent undesirable delays, does this call for a bigger, faster C.P.U. (as the manufacturer's representative may suggest), or is there a bottleneck in some less costly peripheral, or at some unsuspected interface, or is the trouble an ill-designed operating system which mismanages the flow of data?

To find out how much of its time each part of a computer system spends actually working, one can attach metering probes at various points. This is called hardware monitoring, to distinguish it from software monitoring, in which special-purpose programs are written, ordering the machine to report on its activity. Dr. Gary Carlson, of Brigham Young University, told of his recent findings from hardware monitoring at the annual meeting of the Association for Computing Machinery, held this summer in Boston.

A common "fallacy of intuition", he discovers, is to believe that the C.P.U. is far busier than it actually is: "In most installations monitored we get a C.P.U. usage in the 30 to 40 per cent range. Almost always the operational people explain that we caught them at mid-month and that things would measure much busier at the month-end processing cycle." But, on returning at the end of the month, "almost without exception the net effect of 'peak loads' is a very slight increase of two to four per cent 'C.P.U. active' and a large relative increase of 'printer busy'."

Among his successes Dr. Young counts the occasion when a 360/30, apparently working 24 hours a day, turned out to be able to complete the same daily load in 18 hours, given a minor program modification; upgrading to a 360/40 was postponed for—to date—a year, at a saving of $45,000. At a police data-processing facility which had two 360/40's, each with its own tape unit, it was found that the tapes were working simultaneously just 0.06 per cent of the time, and that one of the two tape-control units could therefore be replaced with a two-channel switch, at a saving of $440 per month; one of the 360/40 C.P.U.'s was working only 25 per cent of its time, and could have been downgraded (but for "non-technical considerations") to a 360/30, at a saving of $950 per month.

It is not that hardware monitoring is by any means a new technique. "In years past there has been a lot of monitoring activity internally within hardware manufacturers, but apparently," as Dr. Carlson put it, "some concern has been felt about misinterpretation of monitoring activity among the users."

He expressed the hope that manufacturers were beginning to cooperate with users who wish to monitor their equipment: that, for example, they would provide "permanent wiring from critical pins down to easy-access pins where we don't have to practically dismantle the machine to attach the monitor." Brigham Young University already makes this a requirement in its bidding procedures. "It seems to us that this kind of activity keeps the vendor honest. If they have made claims, their claims should be measurable."—*F.W.*

Data Systems: How To Ask Questions

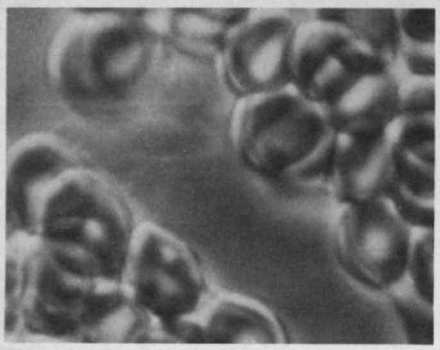
"Developing professional solutions to the problems caused by the maldesign or malfunction of computer-based information systems" is the worthy goal of the Systems Improvement Committee (S.I.C.) of the American Federation of Information Processing Societies (A.F.I.P.S.). In November, A.F.I.P.S. gave its approval to a strategy which this summer reached the stage of the signing of a contract.

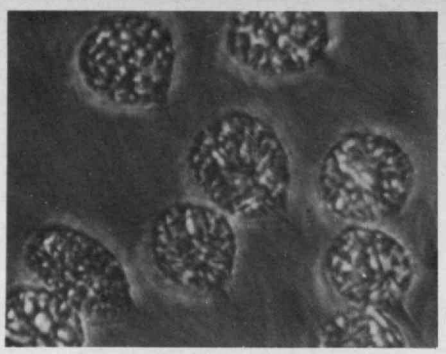
The contract went to Mary E. Stevens, an independent data-processing consultant, for the preparation of the first A.F.I.P.S. System Review Manual. The manual is intended to provide a "heavily annotated checklist" of questions which should be asked about a given large-scale computer system in order to evaluate its performance as regards (in this particular case) security and privacy. If all goes well, subsequent manuals will focus on reliability and other qualities.

Dr. Stevens' proposal for a manual was selected from just four that S.I.C. received, following a request that was sent out in April. ("We didn't know whether to expect zero responses or a hundred," comments S.I.C. chairman John A. Gosden, who is Vice President of the Equitable Life Assurance Society.) According to the request, a manual might contain three sections: ideal concepts, with related questions; "probe" questions for the central task of evaluation; and a collection of "horror stories" with, for each possible blunder, at least one question which would help discover whether the proposed data system suffered from that particular shortcoming. Mr. Gosden describes all of the proposals as having been "responsive" to the S.I.C. guidelines. All four related to the topic of security and privacy, which S.I.C. had admitted "leaning towards" while leaving the bidders free to choose.

By June 1973 the first manual should be ready for field-testing, and the first moves to generate further manuals may be in progress. Mr. Gosden is clearly playing the project by ear, with a very open-minded attitude toward what to hope for from those who might be expected to benefit from the manuals. As to the economics of the scheme, it could eventually be self-supporting through sales, but the initial rate of progress depends on whether real support comes from users of data-processing equipment.

One ultimate objective of A.F.I.P.S. is (to quote the background statement from the April request for proposals) "certification of systems . . . based upon standards or a code of good practice"—at present impossible for lack of "especially . . . a current base of good enough practice from which to construct standards." But, given a really effective procedure for reviewing computer systems, it would be possible gradually to build up a collection of completed reviews, which would provide realistic guidance for the formulation of codes of acceptable practice. Meanwhile, the manuals should at least make it possible to "determine the implied principles and actual practice intended in a system"—i.e., figure out what, for better or worse, it is really designed to do.—*F.W.*





The blood cells on the left will not survive—ice has formed inside and outside the cells. But those on the right stand a very good chance of living through their extreme experience. Ice has formed around, but not inside, them. Cells so frozen have been chilled to near absolute zero, and returned to body temperature in good condition.

LIFE SCIENCES

Life at −272.29° C.

Individual cells can remain alive through far colder temperatures than occur naturally on earth. The Cryogenic Laboratory at M.I.T. has shown that red blood cells can survive storage below one degree above absolute zero.

The freezing of blood cells, even at temperatures considerably above absolute zero, is nevertheless difficult—but necessary. Whole blood can be used for only three weeks after it is drawn; since there are eight different types, maintaining a blood bank in the proper balance is a challenge. But now it turns out that thawed red cells in a saline solution can substitute in some cases for whole blood, and many blood storage problems may be simplified. Charles E. Huggins, clinical director of the Massachusetts General Hospital Blood Bank who is Lecturer of Mechanical Engineering at M.I.T., and Ernest Cravalho, Associate Professor of Mechanical Engineering at M.I.T., told the Seventh Thermophysics Conference of the American Institute of Aeronautics and Astronautics last spring of their success and their hopes.

When red cells are simply frozen, without special treatment, ice crystals form in the suspending medium and the salt concentration in that medium increases. Liquid osmoses out of the cells, to maintain concentration equilibrium within and without, and the cells become dehydrated, thin, and squashed. Some die from that. Others, less dehydrated, adapt to their new salt concentration—so surmises Kenneth Diller, one of Dr. Cravalho's associates. When the suspension thaws, water osmoses back into the cells—again in an attempt to restore concentration equilibrium inside and outside of the cells. But, adapted to a new salt level, the cells cannot contain the amount of water they once did and survive. They burst and release their hemoglobin—the stuff that binds and carries oxygen all over the body—in a process called hemolysis.

Several years ago, Dr. Huggins discovered that packing the red cells in a medium that contained glycerol and sugars all but eliminated hemolysis. The glycerol solution somehow subdues the disequilibrium across the cell membrane caused by the ice outside. At the Massachusetts General Blood Bank, he has kept cells frozen at −85°C. for up to seven years.

When Dr. Cravalho and his associates at the Cryogenic Laboratory developed a new microscope, they joined Dr. Huggins in trying to see just what happened in the cells as they froze and thawed and how much cold they could take. They froze samples at −85°C., −196°C., −268.9°C., and −272.29°C. Even at the coldest temperature, only four per cent of the cells hemolyzed as they were returned to body temperature.

Cells die if ice forms within them as well as outside, and so the rate of freezing is important. A rate slower than a 6°C. drop per minute never caused ice inside the cells, one faster than 17°C. per minute always did, and between those two rates ice formed in direct relation to the speed of cooling.

The authors hope by more observation to see why cells in a glycerol and sugar medium survive better; why even at temperatures near absolute zero no ice is formed in a properly treated cell; and perhaps what can be generalized about the process so that many kinds of cells (besides blood and sperm cells and the few others now successfully frozen) can be preserved by very low temperatures.—*J.K.*

Life in the Desert

The more complicated a life form is, the more temperate and dependable must be its environment; the only creatures that can adapt to radical and changing environments are the very simple. Man can control his surroundings to suit his needs, but simpler living things have an ingenious array of unconscious mechanisms that help them.

Deserts demand that their inhabitants must adapt not to only one extreme but to several, such as heat, cold, extreme dryness, and occasional floods of moisture—Neil Hadley, a zoologist at Arizona State University, finds, for example, that some cacti can handle temperatures of from 130° to 140°F., some lichens more than 160°F. Scorpions and some beetles manage to live with maximum temperatures that approach 120°F.

He observes (in *American Scientist*, 60:338-347), that plants and animals, so different in nature, have in fact solved the problems of desert living in very similar ways.

Animals can burrow in the sand if they are small enough; larger ones can orient their bodies to parallel the sun's rays and so absorb less heat. Similarly several species of cacti characteristically orient their leaves either along the lines of the sun's rays or perpendicular to them to accept the amounts of radiation with which they can best deal.

The Old Man cactus is covered with a dense mat of hairy spines; such a covering can keep underlying tissues 20°C. cooler than they would otherwise be; the Totem Pole cactus has knobs and knurls that deflect and scatter the sun's radiation. Such surface features have exactly the role of an animal's fats and fur; they reflect and dissipate heat—and they provide a layer of insulation against cold.

The stem tissues of the Hedgehog cactus, a large succulent, conduct heat poorly to the inside; the high daytime temperatures thus have their effect in the night hours, when the plant's center is warmer than it would be if exposed. The plant's metabolic processes are assured a more even temperature.

The peculiar demand of desert heat, of course, is that the object cooling itself cannot waste water in doing so. So both plants and animals, after shielding themselves from as much heat as possible, also seek to reduce evaporation. Both desert plants and insects have pores for the exchange of carbon dioxide and oxygen between the circulating fluids of the organism and the air outside. In both, the pores are deep, for protection of their fluids, and both close their pores when heat is intense. —*J.K.*

(Continued from p. 15)

movement was seizing upon any and all available examples to disprove the then currently accepted theory that the Negro race was intellectually inferior, his calculation of a series of almanacs was publicized with great vigor as a symbol of black intellectualism. The fact that it was mathematics that he was good at was not really important. The publicity calling attention to his ability would have been as effective if he had been an artist or an engineer. Since he had no effect on the development of mathematics, his being a scientist is quite incidental to the thrust of the book, which is really a contribution to the field of black history. The book, nevertheless, is an illustration of a not uncommon treatment of a scientist where the science itself is subordinated to other emphases.

In sharp contrast to the Banneker biography is *Einstein: The Life and Times.* Here the full drama of a scientific genius is enmeshed in the turbulent times in which he lived and his effect on society is directly attributable to his scientific contributions. This is an exciting book for students to read because so many of the names associated with the laws, the theories, the effects and concepts which they meet in their physics textbooks become real people, pushing and hauling, loving and scrapping in such a way as to underline physics and mathematics as a most human endeavor.

Writing a biography about our own times has, of course, advantages as well as drawbacks. The advantage is the obvious one that many of the readers have first or secondhand knowledge of the people and events. In this respect the Einstein book is timely, "relevant," and very real. The disadvantages come from lack of perspective, the lack of possibility for a scholar to view a man's life against the background of the historical developments which the man himself is affecting. Current biographies have their very definite place in our literature, but they have to be built on in subsequent generations as history sorts out the important from the unimportant, the complete from the incomplete.

The third book of this group illustrates precisely the importance of the historical perspective in the hands of a first-class scholar. Charles Gillispie's *Lazare Carnot, Savant* deals with an important scientist who is almost unknown to physicists today though much better known to French historians as a leading political figure between the French revolution and Napoleon. Carnot's two great contributions were his theory of machines and his work on differential calculus. Without neglecting Carnot's political history, not only does Gillispie put Carnot's work in its proper place in the development of the concepts of work, energy, and power, but carefully shows the connection between Lazare Carnot's work and the thermodynamic principles introduced by his more famous son, Sadi Carnot.

The Carnot book illustrates another facet in the technique of interesting students as well as teachers in the usefulness of biography as a teaching method. Both of Carnot's classic papers are reproduced in the volume. Although the French language may deter some from using them with profit, the one real difficulty with the "Dissertation sur la théorie de l'infini mathématique" has been clarified by the editorial collaboration of Professor A. Youschkevitch, who introduces this paper with a section putting Carnot's unfamiliar mathematical procedures into modern terminology. This is a good illustration of excellent editing of original works.

The final book in this quadruplet is in a way an extension of the reproduction of original scientific papers. It is the reprinting of correspondence, selected and edited to be useful and interesting to students of a man and his times. This is more of a reference book than a biography, and the *Selections from the Scientific Correspondence of Elihu Thomson* are arranged by correspondent. But when the correspondents of Thomson are people like Sir William Bragg, W. D. Coolidge, Thomas Edison, Sir John Fleming, Dayton C. Miller, George Sarton, Harlow Shapley, Samuel Stratton, Silvanus

Thompson, and Willis Whitney, among others, both the humanity of the people and their quest for knowledge become fascinating and exciting.

The Answer Is Ham-on-Rye

Puzzle Corner:
Allan J. Gottlieb

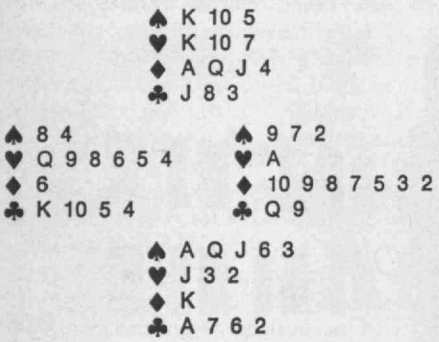
Tonight I was able to listen to "Sports Huddle" for the first time in a year. As I mentioned before, Central California may have beautiful weather but it has awful radio programs—and sports coverage. So it's good to hear Eddy, Mack, and Jim after such a long absence.

I've just finished my first two weeks of full-time teaching. They were enjoyable—and, I feel, successful . . . and I wonder if my students feel the same way. It is hard to realize that my school days are over and I'm all grown up now; it seems like only yesterday when I went to my first class at M.I.T. I remember it well. The class was 8.01, the room was 26-100, and I was late.

Problems

This month we start with a bridge problem from John Schwartz:

DE-1 Here is a hand actually encountered at the bridge table:



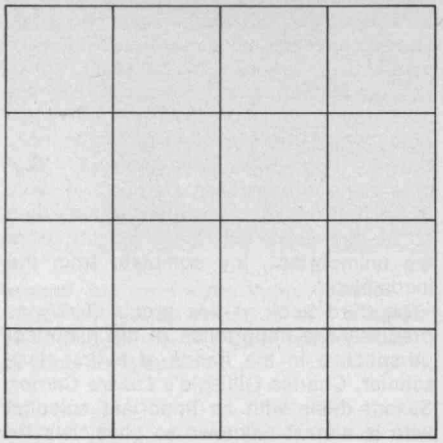
West leads ♦6. How is South to make six spades?

The following is from Frank G. Smith:

DE-2 Give an algebraic proof of the following geometrical construction method for inserting within a circle a figure of any number of sides:

1. Draw the diameter of any circle you may have chosen.
2. Divide this diameter into the number of units you wish to have inscribed in the circle.
3. At the extremities of this diameter, scribe two intersecting arcs with radius equal to the diameter.
4. From the intersection of these two arcs draw a line through the second division point from the circle, extending it to the circle.
5. From this intersection with the circle, draw a line to the (zero) point of the diameter on the circle. This line will then be the side of a figure inscribed in the circle, having the number of sides into which the diameter was divided.

A magic square from George L. Uman:



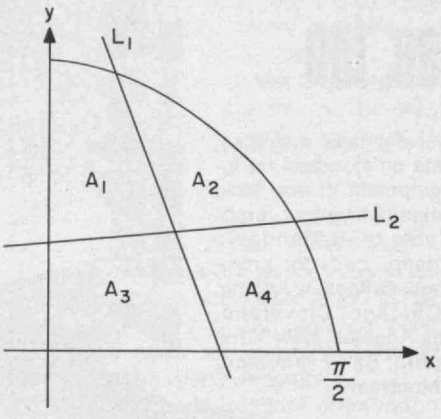
DE-3 In each of the 16 squares of the figure, place a *different* letter, selected so each row, column, and long diagonal will spell a *different* four-letter word when the letters are selected consecutively in one or the other of the only two possible directions, as we do with numbers. There will be a total of 10 different words, all of which must be defined in any one edition of Webster's dictionaries.

Richard Lipes submits the following problem, reporting that he has solved it but only by resorting to a computer to solve a transcendental equation involving x^2, sin x, and cos x; he asks if any "Puzzle Corner" reader can find a solution without a computer.

DE-4 The area under the curve

$$y = \cos x, \quad 0 \leq x \leq \pi/2$$

and the line $y = 0$ is to be divided into four equal areas by a line parallel to the y-axis and another line. Give the equation of the two lines. (In the drawing, areas $A_1 = A_2 = A_3 = A_4$.)



The following trigonometry-algebra problem has been submitted by Paul Schweitzer.

DE-5 Find all solutions to

$$\sin (x + y) = \sin x + \sin y.$$

Speed Department

SD1 Clark Tompson wants you to devise an algorithm for extracting cube roots.

SD2 Victor Sauer wants to know if this is modern mathematics or an Italian story: Seven persons buy a car and the mathematician in the group arrives at $13 per person for a $28 car:

$$\begin{array}{r} 13 \\ 7\overline{)28} \\ \underline{7} \\ 21 \\ 21 \end{array}$$

One of the other six of the group questions the amount, but the following addition proves the mathematician to be correct:

$$\begin{array}{r} 13 \\ 13 \\ 13 \\ 13 \\ 13 \\ 13 \\ \underline{13} \\ 7 + 21 = 28 \end{array}$$

Solutions

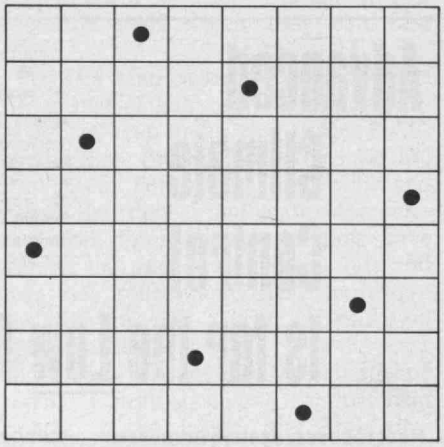
The following are solutions to problems published in *Technology Review* for June, 1972:

JN-1 (a) On a chess board, place eight queens such that no queen is vulnerable to other queens—i.e., no queen should be in the path of other queens.

(b) Obtain one or two general patterns for placing 2n dots in a grid 2n x 2n ($n > 1$), with the same restriction as above.

(c) Extend the solution for (b) for placing n dots in a grid n x n ($n > 3$).

Arthur L. Kaplan believes his solutions are unique; the solution to (a) is in the form of this diagram:



(b, c) (1) For n equal to any of the numbers 3i + 4 in the case of the 2n x 2n grid, or for n equal to any of the numbers 6i + 8 in the case of the n x n grid, use the same pattern as that for the 8 x 8 grid in (a), starting at the left side three squares from the bottom, working toward the upper edge one square to the right and two squares up until the upper edge is reached, and then placing one queen two squares to the right and one square down, and then repeating the pattern symmetrically on the other half of the grid.

(2) For n equal to all other digits, start at the left side, one square from the bottom, working toward the upper edge one square to the right and two squares up; when the upper edge is reached, start in the next column to the right at the bot-

tom square and work up one square to the right and two squares up, until the right edge of the grid is reached.

Also solved by Robert L. Bishop, R. E. Crandall, David Merfeld, R. Robinson Rowe, Victor Sauer, Brian Witzke, Harry Zaremba, and the proposer, Benjamin Whang.

JN-2 What simple rule governs this sequence:
1,1,2,1,2,1,2,3,1,3,2,1,2,3,3,1,3,2,1,3, 2,3,4, . . .

The proposer, Mary S. Krimmel, notes that the entries are half the differences between successive odd primes.

Also solved by R. E. Crandall

JN-3 As mentioned last month, there was a serious omission in the original published version of this problem. Complete, it should read:
Show or prove that

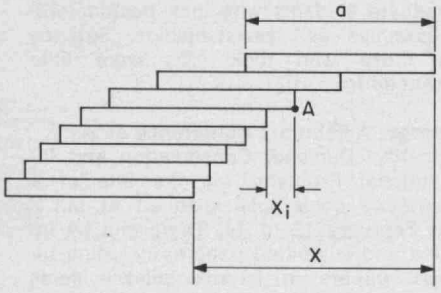
$$\left(\frac{1-x}{1+x}\right)(2x+1)\prod_{k=1}^{\infty}\left\{[1+x^{2k}]\left[1+\left(\frac{x}{1+x}\right)^{2k}\right]\right\}=1$$

$$-\frac{1}{2}<x<1.$$

I will give the solution along with those to the October/November problems, in the February issue of *Technology Review.*

JN-4 You are given as many playing cards as you wish to use, each of length a and width b. They are stacked one upon another in the usual way, so that each card is in contact with only the cards immediately above and below it, with the objective of achieving the maximum overhang before they fall over. What is the length of this overhang?

The following is from Harry Zaremba:



Assume the edges of all cards along their length (a) are in vertical planes. Beginning from the top, let the edge (b) of each successive lower card be placed under the center of gravity of the cards above. The center of gravity of i cards located from edge A of the ith card is given by

$$x_i = a/2i.$$

For n cards, the total overhang will be

$$x=\sum_{i=1}^{n-1} x_i = a/2 + a/4 + a/6 +$$

$$. . . + a/2(n-1), \text{ or}$$

$$x = a/2[1 + 1/2 + 1/3 + 1/4 +$$

$$. . . + 1/(n-1)].$$

The overhang could be constructed without a limit since the series in brackets is divergent for $n \to \infty$. If the diagonals of all cards are in a vertical plane, and the corner of each successive lower card is placed under the center of gravity of the cards above, then the maximum overhang for n cards is

$$x = \{(a/2)^2 [1 + 1/2 + 1/3 +$$

$$. . . + 1/(n-1)]^2 + (b/2)^2 [1 + 1/2$$

$$+ 1/3 + . . . + 1/(n-1)]^2\}^{1/2}$$

or

$$x = \frac{1}{2}[1 + 1/2 + 1/3 +$$

$$. . . + 1/(n-1)]\sqrt{a^2 - b^2}\,.$$

Also solved by R. E. Crandall, R. Robinson Rowe, and the proposer, Roy Sinclair.

JN-5 Find the cube root of INVENTORY and verify that it can be eaten or drunk.

The "best" solution is from David E. Anderson:
The cube root of INVENTORY is RYE:

$$\sqrt[3]{317214568} = 682$$

$$\sqrt[3]{\text{INVENTORY}} = \text{RYE}$$

The problem therefore has two solutions: rye can be eaten as in ham-on-rye or drunk as in rye whiskey.

Also solved by Winslow H. Hartford, Richard Hill, John Prussing, R. Robinson Rowe, Greg Schaffer, Harry Zaremba, and the proposer, R. E. Crandall.

Better Late Than Never

The bridge problem which appeared as number **51** in the January, 1972, issue of the *Review* comes in for criticism from Ed Nordstrom, and my lack of bridge mastery has obviously again caused problems. Mr. Nordstrom writes:
If play proceeds as outlined in the "solution" published in the *Review* for May, with four cards to play the hands would be
West:
♥ J 7 6
♣ K

South
♠ 5
♥ Q 10 3

Now what self-respecting West would throw away the ♣K if the last trump (♠5) were led? I still maintain that proper defense will set this contract.

Comments on the solution have also come from Alan La Vergne, Richard C. Lesser, and Lars Sjodahl.

Mr. Gottlieb, who graduated in mathematics from M.I.T. in 1967, teaches mathematics at North Adams State College, North Adams, Mass., 01247. Send problems and solutions to him at that address.

An Institute Informant

The Editors' digest of recent and current concerns at the Massachusetts Institute of Technology

Managing Technology

When Professor Donald G. Marquis accepted his new Sarnoff Professorship in the Management of Technology this fall, he chronicled for the press some aspects and results of the 10 years of research on the topic which he has led in the M.I.T. Sloan School of Management: what kind of engineers best succeed in new enterprises seeking to capitalize on new technology; what factors influence the success of contract proposals; how innovation works. The key factor in communicating technology—in contrast to science—is people, not paper. ("Experience in design, materials, and processes cannot be communicated in technical papers," said Professor Marquis; and communication within a plant works better in the horizontal than the vertical mode—hence a suggestion to avoid high-rise buildings for research and development laboratories.) Professor Richard S. Rosenbloom, receiving a similar professorship in the Harvard Business School, explained the quickening management interest in the field: technology is at once a threat and an opportunity for every manager. The "generation gap" is a key issue here, he said: "We have given the new generation what we ourselves could not achieve," and so we can now concentrate on "needs that separate our accomplishments from our goals."

Innovation Now and Later?

The great opportunity for M.I.T., as it is for all institutions centered in science and technology, is to better manage "the tremendous power which technology makes available, while remaining sensitive to the impact of new technology on the natural and man-made world." The need is "to find ways to apply the knowledge and skills of science and technology to the pressing problems of our society . . . in ways that do not generate problems of greater complexity" for the future.

Those are the judgments of Jerome B. Wiesner and Paul E. Gray, President and Chancellor, respectively, in their first annual report as leaders of M.I.T. They record in detail the Institute's programs to help its students understand and prepare to deal with the effects of technology and to mold research to be responsive to them. In teaching programs, the thrust is to greater flexibility and to improving "the social environment of education;" in engineering, for example, toward a "new perspective that adds a 'needs analysis' and an 'impact analysis' to the traditional concepts of engineering solutions."

The Elusive Goal of Financial Stability

One index of the financial strength of a private university is its freedom to use unrestricted resources for special purposes, not to meet a gap between revenues and expenses. Measured by this—or any other—standard, M.I.T. is now "one of the strong institutions" among private universities in the U.S., says Joseph J. Snyder, its Vice President and Treasurer.

In 1971-72 the Institute needed only $2.9 million of unrestricted resources to meet the operating budget; $1.5 million was transferred to endowment.

This demand for unrestricted funds was not only less than the previous year; it was smaller as well than the amount budgeted. One cause is that M.I.T. departments and laboratories ended the 1971-72 year with unexpended balances of about $1.5 million—the result of putting into effect during one year the cuts and economies which had been budgeted for the following (current) year.

Despite these short-range successes, Paul E. Gray, Chancellor of the Institute, is not optimistic. Costs are rising faster than income by about $1 million a year, and the difference compounds annually.

Awards

To Ross A. Chapman, former Director-General—Food and Drugs in the Canada Department of National Health and Welfare, M.I.T.'s Underwood-Prescott Award for contributions to food science and the food industry. . . . The James R. Killian, Jr., Faculty Achievement Award to Dr. Nevin S. Scrimshaw, Head of the Department of Nutrition and Food Science; Dr. Scrimshaw will respond with a series of lectures at the Institute in the spring . . . the first Harvey Prize of the American Society for Technion—Israel Institute of Technology to Claude E. Shannon, Donner Professor of Science.

Research: Growth and Conversion

While gloomy news came from one office of M.I.T.'s research administrators *(see below)* good news came from another: a forecast that sponsored research at M.I.T. will exceed $200 million for the first time in history in 1972-73. The increase—from $186 million to $207 million, some 11 per cent overall between 1971-72 and 1972-73—exceeds the cost of inflation and thus represents real growth in research volume.

"Conversion" is a reality. The National Science Foundation will sponsor 22 per cent of on-campus research in 1972-73, while the Department of Defense sponsors only 16 per cent; the figures were almost exactly reversed in 1971-72. The Department of Health, Education and Welfare's share will be up from 15 to 19 per cent.

Meanwhile, the annual compilation by the National Science Foundation showed M.I.T. the highest of all U.S. universities in terms of federal funding in 1970-71—over $89.5 million, compared to the University of Minnesota's $72.5 million and the University of Michigan's $60.8 million. In that year total federal funds to universities and colleges were $253 million more than in 1969-70—an 8 per cent increase. It was the first increase (2 per cent) in "constant dollars" since 1966-67, the National Science Foundation said.

A Step Toward Divestment

A "major step" toward divestment of the Charles Stark Draper Laboratory from M.I.T. has been achieved with agreement on the "overhead" to be paid for government-sponsored research at M.I.T. in 1973-74. The rate will be adjusted upward to (partially) compensate for the loss of overhead from the Draper Laboratory which—if present plans materialize—will be independent by June 30, 1973. But the adjustment will have the effect of reducing by about $2 million M.I.T.'s government income from government-sponsored research for maintaining such general services as libraries and administration, and a round of budget-cutting may be in prospect.

Jobs: Hard, but not Impossible

M.I.T.'s Director of Placement says that—while job-hunting was sometimes long and hard—unemployment among members of the Class of 1972 is by his standards "low." And whatever the difficulties, students "insisted on jobs in the mainstream and were not content to drift into a backwater. . . . Candidates maintained a healthy discrimination in choosing employment."

Signs of difficulty are found in the large numbers of students who used their undergraduate degrees as admission to graduate schools—particularly medical and law schools; the numbers of foreign students who went home instead of taking jobs in the U.S., and the numbers of graduate students who took postdoctoral fellowships and assistantships. Salaries for those who took jobs were little changed from 1971.

Energy: A February Conference at M.I.T.

"Energy: Demand, Conservation and Institutional Problems" is the title of a three-day conference planned at M.I.T. for February 12 to 14. There will be invited and submitted papers, including tutorial papers in interdisciplinary fields such as technology assessment and economic policy.

Potential authors have been asked to submit papers on any one of these themes: energy demand and projections, energy sources and supply questions, gas supply and demand, energy in transportation, the transport of energy, institutional barriers to energy development and conservation, energy technology assessment, energy conservation, social impacts of energy use, capital investment and input-output methodologies in the energy industry.

Sponsorship is by the RANN Program of the National Science Foundation and the Industrial Liaison Program and School of Engineering of M.I.T.; registration information is available from Michael S. Macrakis, Industrial Liaison Office.

REPORT OF THE PRESIDENT AND THE CHANCELLOR

FOR THE ACADEMIC YEAR

1971–1972

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY

Leading the new Administration at M.I.T. are President Jerome B Wiesner and Chancellor Paul E. Gray.

We close our first year in the stewardship of M.I.T. with enthusiasm. We are buoyed by a sense of modest accomplishment, a deep confidence in the basic integrity and quality of M.I.T., and the dedication of the Institute's faculty, staff, and students to the goal of continued excellence in knowledge and learning. Most importantly, we emerge from our first year with a firm conviction that a major challenge remains for M.I.T. and its graduates, a challenge from the nation and the world to find ways of applying the knowledge and skills of science and technology to the pressing problems of our society, many of them wholly new human and social problems.

The progress in the past year of each department, School, and laboratory is described in detail by our colleagues in their annual reports. In this prologue to their reviews we will attempt to look toward the future of M.I.T. as a whole. Our goals are to identify those recent trends and present activities in which are embodied the elements of tomorrow's Institute and to evaluate the Institute's strengths and needs in meeting the challenges now before it.

For the new administration – the Provost, the Chancellor, the President, and our colleagues – the past year was, at once, a period of taking stock, of getting acquainted with new responsibilities, of seeking new directions, and of gathering momentum for efforts already begun. It was also a time that required the intensive involvement of the senior officers of the Institute in fiscal issues of major importance and persistent urgency. The relentless rise in costs due to inflation, the impact of rising tuition on our students and their families, as well as on our resources for financial aid, and the decline of Federal support for graduate education have been particularly vexing concerns and have absorbed a major portion of our energy and time. The primary issue is not that of short-run solvency or stability. Rather, it is the challenge of managing the growth of costs and the allocation of resources in ways that encourage innovation and creativity in education now, while simultaneously strengthening the fiscal basis of M.I.T. for future generations of students and faculty. We have made a start in understanding and dealing with these problems. There is clear evidence after a year that the short-range fiscal problems can be managed in ways that do not weaken our essential activities in education, in research and scholarship, and in service. Longer term concerns, dominated by a persistent difference in the growth rates of expenses and income, will continue to have a high priority for us.

CRITICISM AND LEADERSHIP: THE MODERN DILEMMA OF THE UNIVERSITY

By far the most heartening feature of the past year has been the progress made on important intellectual fronts, progress which is reflected in major shifts of learning opportunities through the development of new academic programs and new research activities.

Underlying most of our new efforts is the growing conviction that, in spite of the current anti-science, anti-technology mood in many quarters, continued progress and the creation of a more acceptable world will require major new technical developments as well as modifications in social patterns. Furthermore, there is a growing realization that the problems for which science and technology

have been blamed stem not so much from the development of technologies but from their profligate use by a society too slow to appreciate that what is highly beneficial on a small scale could be very damaging when employed massively and, consequently, might require social inventions to match the technical developments.

Foresight and innovation lacking, the temperature of social unrest has risen, producing a dissatisfaction with many aspects of the status quo. This is a worldwide phenomenon, but several aspects of our society make the situation more acute in this country than in many others. Because we are the technological leaders of the world, many of the troublesome side effects of a technological society occur here first. Classical examples are, of course, pollution, urban decay, and traffic congestion; but there are also more subtle, more difficult attitudinal problems, such as boredom in highly automated manufacturing plants or the feeling that the interests of people are being sacrificed to the development of impersonal bureaucracies and data processing systems.

In addition, two special problems have added greatly to the internal stresses in our society and especially in the university – the black struggle for admission to the full range of opportunity in American life and the continuing cancer of the Vietnam war.

To a greater or lesser degree, socio-technical, racial, and war-related problems, as well as others posed by size and complexity, have made an impact on most social organizations, including the various parts of government, industry, and the educational system. Because all of these major units of society play a role in the modern industrial state, they have all been criticized to some degree for the appearance of the unanticipated painful and frightening features of the modern world. Government is criticized because it is expected to deal with social problems as they emerge and has not done so quickly enough; industry is criticized because it has made the creations of technology widely available and consequently is increasingly expected to anticipate or assume concern for the safety and long-range effects of its products.

The educational system, particularly the university, is challenged on many fronts. Colleges and universities have been expected to accept the greatly enlarged and more diverse group of students now seeking higher education. The size of this group and the wide diversity of its intellectual background has strained the abilities of universities to maintain high quality in educational programs and to preserve those intellectual traditions which they harbor and pass on to their students. At the same time, universities have been expected to augment their intellectual capital. Only thus could they provide leadership both in helping to solve the pressing problems of the times and in ensuring that graduates would be prepared for life in a rapidly evolving and unpredictable society. The expectations for preservation, on the one hand, and renewal, on the other, conflict in part; and it is not surprising that few people have been happy with the results. Students have frequently viewed the universities as perpetuators of the status quo. Many older citizens have tended to view them as breeders of radical thought. Both groups have criticized them bitterly.

Uneasiness in the society at large has been inevitable, and, to some extent, protest and criticism have helped to focus attention on important problems. The presence of disruptive protest in our society was an almost existential shock to many, and it took some time to fully absorb its meaning. But protest and criticism do not provide solutions, and the need for creative leadership through education stands out.

Universities everywhere are searching for their particular contributions to the current social challenge. Some have been weakened by the pressures of crisis; many – ours among them – have emerged stronger and healthier from the trials of internal strife. The course ahead may be less dangerous, but it is certainly more difficult, for the goal is not mere survival.

There is now a widespread realization that there is a need to consciously manage the tremendous power which technology makes available, while remaining sensitive to the impact of new technology on the natural and man-made world. We realize that the task in the years ahead is not only to find solutions to many pressing problems but to do so in a way that does not generate different problems of greater complexity. In fact, one of the immediate tasks is to handle problems such as pollution without creating a whole set of new crises in related fields such as energy or agriculture.

To make any progress, one must first come to regard the current dilemma not as a result of massive failures to be castigated but as the opening of new opportunities. The dilemma has resulted from a great success in applying technology to human purposes and from an unprecedented achievement in making technological advantages widely available to people everywhere. Mankind has not been prepared for the suddenness of this success. We have to learn in a very short period how to consider the collective effects and long-range consequences of actions, as well as their first-order effects. We must learn to do this without losing the advantages of large-scale technology. This has already begun to happen. It can be seen in the restraints that are placed on activities which could have an adverse impact on the environment and in the emphasis that we see in the growing movement for corporate social responsibility. It is also highly visible in the career choices of students, in the legislation of local, state, and Federal governments, and in the international efforts that are developing to understand the nature of man's impact on the natural world. It is particularly exciting for us at M.I.T. to see this effect in the changing academic and research interests of both faculty and students.

TEACHING AND RESEARCH: ACHIEVEMENT IN PERSPECTIVE

The response of the faculty and student body at M.I.T. to the needs of contemporary society can be seen in new academic and research programs. Traditional academic disciplines and established professions are by no means obsolete, but they do not necessarily provide the most effective nor the most powerful means of focusing our talents on the great social issues of the day. Most Schools and departments at M.I.T. have been struggling to identify an intellectual core which is more appropriate to today's

needs than were earlier formulations. This struggle takes place in two areas – in teaching programs and in research. Effective new academic programs require complementary creative intellectual effort to support them; and new intellectual fields, in turn, depend on coming generations of professionals who have been trained in new ways to meet new challenges.

For example, in focusing engineering skills on today's world, there has developed at M.I.T. a new engineering perspective that adds a "needs analysis" and an "impact analysis" to the traditional concepts of engineering solutions. Thus, the points of view of the social sciences and of systems analysis are added to the conventional technical scientific knowledge which forms the underpinning for the profession.

A similar broadening of interests in other fields has generated many interdisciplinary and inter-School efforts, both in research and in academic programs. Engineering, the physical and biological sciences, the social sciences, and the humanities are building new channels of communication with one another. The new emphasis has also opened up many desirable avenues of collaboration with industry and government.

For some, the response to social needs appears too slow; for others, it is obviously too fast. Many people find frustrating the slow rate at which we have been able to clarify our tasks, but considering the complexity of these issues, halting progress should not be surprising.

The great danger remains that cumulative effects of the social confusion and economic limitations will inhibit the sound evolution of educational programs to fit the new needs. We have been somewhat disappointed at the rate at which we have been able to attract outside support for many of the new programs at the Institute. Furthermore, the shortage of M.I.T. venture capital caused by necessary budgetary stringency has forced cutbacks in some existing programs and has required everyone to work a little harder on them. This makes it difficult to find extra time and internal resources for the establishment of new programs. Yet, there has hardly been a time in the history of the Institute when challenges were greater and the opportunities for academic, technical, and social contributions more numerous. Some support for most of the worthwhile experiments has been found. We hope this will continue to be possible.

Educational Programs

How and what to teach? These are hardly new questions, especially for an institution that has been the intellectual leader in its field for most of its history. Yet today these questions are regarded as more urgent by students and faculty alike than they have been for many decades. The local concerns are but a part of a worldwide reassessment of the character and role of higher education which, in turn, is but a part, albeit an important part, of the major transformations occurring in the society.

The last two decades have been a period of continuous growth and development during which time the American university population more than doubled and the graduate student population grew even faster. The M.I.T. student body nearly doubled in size. Improvements in the quality of elementary and secondary education for a large number of students made it possible (in fact necessary) to upgrade and diversify the content of the courses in the universities, specifically in physics, chemistry, biology, and mathematics. In turn, this focus on content generated an intense interest on the part of a substantial number of faculty in teaching methods and the social environment of learning. As a result, there has been a wave of experimentation and research focusing on contextual aspects of the learning process, as well as on content. The initial work has led a number of faculty members and students to full-time professional careers in educational innovation and research.

Throughout this evolutionary period, two themes have been prominent at M.I.T.: (1) the urge to provide a more flexible learning environment and (2) the effort to provide more mature educational experiences for the students, consistent with their abilities and their needs. As part of the effort to provide greater flexibility, there has evolved a series of optional routes through most of the core subjects, designed to make it possible for most students to engage the subject matter in the way that best suits their preparation and learning style. The experimental programs, reported in earlier years, included a variety of self-paced and tutorial options in freshman seminars, as well as three quite special experimental groups – the Experimental Study Group (E.S.G.), the Unified Science Study Program (U.S.S.P.), and the Concourse Program in which radically different educational experiences were made available. The new opportunities also included the possibility of a degree without specification in several departments, which increased the opportunity for individually planned upper-year programs.

Greater flexibility in an M.I.T. undergraduate education is also advantageous for those undergraduates who see M.I.T. as an ideal preparation for careers in newly emerging aspects of medicine, law, and education. Professional school admissions requirements create additional demands on the student, demands which are somewhat different from the usual preparation for a career in science or engineering. To assist those students, a preprofessional counseling service has been created. As we gain experience with this initial effort, this service may be expanded to provide career development assistance in other areas.

In order to provide more mature experiences for students, we have been trying to make it possible for them to interact in a professional way with the other members of the Institute family – students, faculty, and staff. Through the highly successful Undergraduate Research Opportunities Program (U.R.O.P.), a substantial portion of the undergraduate student body achieved a close collaborative association with members of the faculty, working together on ongoing projects. Such encounters encourage intellectual commitment and self-direction and provide a nearly ideal climate in which students can develop educational self-sufficiency and intellectual independence – habits of mind that are crucial to lifetime effectiveness and satisfaction. This program is now extended to include collaborative opportunities in a number of off-campus institutional settings, including industrial, government, health, and community organizations. We comment further on this important development in a later section of this report.

Finally, the Independent Activities Period in January continues to provide a new dimension to educational activities through the freedom it offers for individual projects, intensive subjects, and exploratory programs that do not fit into the normal academic calendar.

These experiences were sufficiently exciting to lead a Special Task Force on Undergraduate Education to study more deeply both the experimental programs and the recommendations of the M.I.T. Commission on Education (1969-70). In reporting to the Faculty at the close of the previous academic year (1970-71), the Special Task Force made three specific recommendations: that attention to undergraduate education be emphasized by creating a post of Dean for the Academic Program; that a more intimate faculty-undergraduate student relationship be established through a seminar/research activity which might occupy as much as 25 per cent of each student's time during his undergraduate years; and that careers in education, as well as a continuing interest in educational research and development, be facilitated through the establishment of an Education Division. The recommendations were examined this year by the Committee on Educational Policy which endorsed them in a series of reports to the Faculty. They were discussed at special Faculty meetings and endorsed in principle at the end of the year. The administration was given a mandate to implement these changes to the extent that resources and other limitations permitted. Planning for these new initiatives began before the spring term was ended, and it is expected that implementation will begin during the fall term of the 1972-73 academic year.

In addition to these Institute-wide programs stressing alteration in the social environment of learning, the several Schools continued with high interest the reformation of teaching programs reflecting their new intellectual directions. In the School of Engineering, teaching programs which complement new research efforts on the interface between engineering and social policy have been initiated in the Departments of Civil Engineering, Aeronautics and Astronautics, and Ocean Engineering. These teaching programs combine more familiar engineering subjects with systems analysis, pertinent aspects of law and economics, and policy-analysis studies. The School of Science has introduced a new School-wide degree without specification based on the highly successful experiment conducted for several years by the Department of Earth and Planetary Sciences. This option of a non-specialized education in the sciences will provide students with a solid scientifically based liberal education, as well as offering them ideal preparation for a future professional career in the sciences. In the School of Management, new public policy programs have been initiated with particular emphasis on the management of health delivery systems and health care planning. The School of Architecture and Planning has similar concepts, and, in particular, a special effort has been placed on strengthening the capability of the School in the area of natural ecology. A new program will place emphasis on the impact of current environmental policies, the intergovernmental constraints affecting the implementation of those policies, and the problems of assessing environmental situations and requirements. As in the School of Engineering, there is a strong desire to link the educational process with societally related activities, which in this case means breaking down the walls between the university and community through the mechanism of field-linked education and research programs. In addition, the major programs – the HUD Minority Internship Program and the Community Fellows Program – provide a means for substantial minority group participation in the advanced programs of the School of Architecture and Planning.

The educational activities of the joint Harvard-M.I.T. Program in Health Sciences and Technology entered their second year, accepting a second group of juniors and seniors drawn from the two schools. There are now approximately 50 students in the program. Fourteen new subjects have been created in conjunction with this new effort, and many students from areas other than the joint Program at both Harvard and M.I.T. take advantage of them.

Research Activities

Research trends at the Institute reflect the growing awareness of the complex problems industry, government, and the educational system face in this period when society, and the criteria by which the technological innovations are judged, are changing rapidly. To a large extent, the problems which are now receiving our attention are very different from those we are accustomed to solving and, therefore, demand new kinds of solutions – a task requiring creative intellectual efforts of considerable scope and intensity. Many of the problems which now claim our research interest cannot be approached through a single discipline or in a strictly academic mode. They are problems integral to the complex social fabric of our time, whose very identification and definition may be dependent upon a true collaboration between the university and people in other sectors of society. The solutions of these problems depend not only on the intellectual analysis which the university could provide but also on the degree to which those who can implement solutions are convinced of their appropriateness and feasibility. Also, a new criterion has been added to the requirements for a "successful" solution – that its second-order and long-term effects on the society at large be benign.

The evolution of research programs in new and socially related disciplines is the foundation on which the development of academic programs in those fields rests. Obviously there can exist no effective graduate program without a research base to support it, and even an effective undergraduate program in any evolving discipline must ultimately have such a foundation. We have been pleased with the progress thus far because it establishes to a considerable degree the pace at which new academic programs can emerge. Some highlights of the newly evolving research efforts are discussed briefly below.

The research aspects of the joint Harvard-M.I.T. Program in Health Sciences and Technology have continued to develop satisfactorily. An eighteen-member sponsoring committee under the joint chairmanship of Mr. Charles Francis Adams and Dr. George W. Thorn has been established and is now functioning. During the year, a $5 million grant was received from the National Institutes of Health for a program in biomaterials, as well as a substantial

grant for the construction of teaching laboratories from the James and Lynelle Holden Fund. Funds for endowment, and research program support in a variety of areas, are now being sought.

Especially notable during the past year has been the School of Engineering's expansion of research activities related to social applications of technology. Drawing on the strong and growing base of engineering science in many departments, there have been important developments in uses of water resources, ocean engineering, transportation systems, environmental problems, and energy problems (including investigations of electrical power). Under the leadership of Dean Alfred A. H. Keil, several interdepartmental groups have been formed, pooling resources for more effective research and teaching in the fields of transportation, pollution, and energy. In addition, the School has pioneered in the sponsorship of a very successful Sea Grant Program, now funded at over $1 million annually. Also of great interest is a new Center for Policy Alternatives based within the School of Engineering but reaching out both to other Schools within M.I.T. and to operating agencies outside the Institute. The Policy Center will develop alternatives of both action and policy for those social problems which relate strongly to technology or which would benefit from a meaningful application of technology.

During the past year, the Lincoln Laboratory enjoyed a steady and significant technical progress. Traditional program areas such as communication and strategic technology, advanced electronic technology, radar techniques, and seismic discrimination continue essentially unchanged in scope.

The number of new programs being undertaken by the Laboratory is growing, both in terms of size and variety – a very encouraging trend. A major new air-traffic control program under Federal Aviation Administration sponsorship calls for the Laboratory to act as the primary technical agency over the next five years in the development of a Discrete Address Beacon System, which will substantially upgrade existing air-traffic control system capabilities. This program, together with other civilian air-traffic control activities, now comprises about 15 per cent of the Laboratory's total effort.

The ambulatory health care program continues to progress. Procedures designed to permit paramedical personnel to play a larger role in the delivery of health care have undergone successful experimental testing in clinical environments. A self-paced learning system developed by the Lincoln Laboratory is now under test.

June 1, 1972, marked the completion of Draper Laboratory's second year as an independent division of the Institute, and a major portion of the attention and effort of the Board of Directors and Officers continues to be directed toward the very complex business of designing an effective method of divesting the Laboratory from M.I.T. As this is being written, we are close to agreement with the government agencies, who also sponsor research on campus at Lincoln Laboratory, and with the Draper Laboratory regarding the financial implications of divestment to both M.I.T. and the Laboratory.

During the past year the distribution of Draper Laboratory sponsorship was 67 per cent military, 31 per cent NASA, and 2 per cent other. For the forthcoming year, military sponsorship will account for about the same fraction of Laboratory research, NASA programs will decline modestly, and other programs will increase to about 3 per cent of the total. The level of "other" programs in absolute terms remains modest, but the increasing trend is heartening. There continues to be a broadening of the base of applications for the Laboratory's technological capabilities. Continued growth in biomedical engineering, for example, has been recognized by the establishment of a new organizational entity within the Laboratory – the Division of Medicine, Biology, and Health Care Programs. Other involvements in oceanography, industrial process control, and medical instrumentation, to cite but a few, continue to flourish and give great future promise.

To enhance and expand its educational activities, a new Division of Education has been formed within the Draper Laboratory which will seek to establish ties with other institutions which can benefit from the unique resources and capabilities of the Laboratory.

In the area of Institute-wide research policy, the principal focus has been on stimulation of the process of innovation and on mechanisms for quickening the transfer of technological advances from laboratory to general public use. The most significant manifestation of this effort was the founding of a new corporation, the M.I.T. Development Foundation, Inc., chartered by the Commonwealth of Massachusetts on April 3, 1972. The new organization is experimental in nature and will serve to assist in the formation of new enterprises and to provide a communications link among government, industry, and sources of venture capital interested in the development and application of technology developed at M.I.T.

While we are pleased with the scope and progress of research efforts relatively new to M.I.T., we are also encouraged by the improvement of support in M.I.T.'s more traditional areas of work, particularly in engineering and science. This does not mean that all important areas of research on campus are now adequately funded; quite the contrary, since in many important areas of basic science, engineering, and the social sciences, austerity is very much the order of the day. There is still a severe shortage of support for graduate students. Lack of funds for new equipment inhibits work and has made it necessary to terminate some activities prematurely in order that those continuing activities are assured of adequate financing. Nonetheless, the situation is discernibly better, and the outlook for the future is brighter. The present projections indicate an on-campus research volume next year (Fiscal Year 1972-73) of approximately $75 million, an increase of approximately 9 per cent over the previous year, which represents a substantial programmatic increase after effects of inflation have been taken into account. At Lincoln Laboratory research volume increased to $68 million this year, about 16 per cent higher than last year, and will probably climb to $72 million for Fiscal Year 1973. Research volume at the Draper Laboratory, presently about $50 million, is likely to increase in Fiscal Year 1973 to about $60 million, although much of the increase will flow through to industrial subcontractors.

THE ARTS AT M.I.T.

Although creative arts have always flourished at M.I.T. as part of the academic program and of the extracurricular life, 1971 was a year in which two great forward steps were taken through the establishment of a Corporation Visiting Committee on the Arts and the creation of a Council for the Arts at M.I.T.

M.I.T. has nurtured an extraordinary range of artistic activities which are housed in several departments and Schools. In the Department of Humanities, music assumes many dimensions, both in the formal work in the classroom and in the extensive participation by students and other members of the community in performance. There is also creative writing, both poetry and prose, theater and film. In the Department of Architecture, one finds art history and criticism, design, photography, and cinema. The Departments of Humanities and Metallurgy and Materials Science share a program in archeology and ancient technology. The Center for Advanced Visual Studies, interested in affecting the shape and vision of the environment, sponsors a broad range of sculptural and design activities. There is also a faculty Committee on the Visual Arts responsible for art exhibitions and for recommendations regarding the physical environment of the Institute.

Each of these activities is an important element in its sponsoring department, yet each has certain needs which can be best served by interaction between them and simultaneous consideration of their roles and requirements. The new Corporation Visiting Committee on the Arts was created to fill part of this need and to allow the administration and the Corporation to consider these efforts coherently without removing them from the academic environments in which they have grown and now flourish. The Visiting Committee, chaired by Dr. James R. Killian, Jr., has a membership of 11 other people who represent the broad spectrum of the arts at M.I.T.

The Council for the Arts at M.I.T. is planned to fill yet another need that stems from the dispersed nature of the creative arts programs, namely, the lack of an alumni constituency with whom to interact and from whom to draw support. This new Council is comprised of a nationally based, select group of men and women who are alumni, friends of the arts, faculty, staff, and students. Members, appointed by the President for three-year terms, will work closely with the President and Faculty in an advisory role. They will relate to the M.I.T. Corporation, the faculty Committee on the Visual Arts, and to other Institute groups concerned with the role of the arts in education. The Council will complement and support the activities of the Corporation Visiting Committee on the Arts and will be supported in all of its activities by the M.I.T. staff. Ultimately the Council is expected to have approximately 100 members, who will convene at M.I.T. at least once a year and who also will be asked to participate in regional meetings in their communities. Subcommittees dealing with specialized activities in the arts will be appointed by the Council.

PROSPECTS AND CHALLENGES

The complexities and, indeed, perplexities that confront us as we consider M.I.T.'s future reflect the complicated and rapidly changing conditions of our world and, perhaps more importantly, the evolving values and attitudes of people toward these changing conditions.

There is no doubt that in this environment of complexity, advanced technology will continue to play a dominant role. For more than a century the Institute and its graduates have had an important hand in the development of technological knowledge and skill. It is our conviction that in the times ahead M.I.T. men and women will have an equally creative contribution to make. Moreover, we feel an added responsibility that stems from our understanding and special competence in science. Our goal as educators, and to some degree as models, should be to help prepare young people to find a constructive, creative, and satisfying role in meeting the needs of society – a humbling task, indeed, when one considers the full scope of these needs.

We are less sure than we may have been in the past just how our educational contributions should manifest themselves. We can point to exciting programs of innovation in teaching and research development, which are efforts in the educational process aimed at both improving the M.I.T. educational scene and providing career opportunities for interested students and faculty. There are shifts in faculty research interests toward activities that contribute to the solution of the great socio-technical questions of the pivotal moment in which we live. These are movements that have gone on for many years but have received new impetus in the last decade. They were slowed, camouflaged, and refocused – some may say strengthened – during the years of student protest. They are now in full bloom. Pressing ahead on these developments for better learning and research with a foundation in science has been and continues to be M.I.T.'s cardinal purpose.

But the turbulent, rapidly evolving society places other major challenges before the Institute, challenges that have not been in the traditional realm of the university. We wish to identify here three such challenges and comment on each briefly.

First, M.I.T., together with other institutions in this society, must rethink and recast the structure of opportunity which we afford those who spend time with us – opportunity for individual satisfaction and self-fulfillment, opportunity for participation in affairs which affect them, opportunity for employment and subsequent advancement. All who study here and work here stand to benefit from greater attention to these basic human needs. Persons employed at the Institute require ready access to opportunities for advancement, as well as greater attention to their needs for personal and career development. Those who study here deserve an education which enriches the essential lifelong process of growth and educational self-renewal and places a premium on self-sufficiency and intellectual independence.

While these goals pertain to all members of the M.I.T. community, at this moment in time we have an especial responsibility to expand opportunities for members of minority groups and women at all levels of the Institute. We must not stand aside from the society as it struggles to consolidate the opportunities for a decent life that now exist. Indeed, we should be innovative and creative in our handling of these difficult problems with the hope that, in

so doing, we will point the way for others as well as enriching our own environment for all members of this community. We must put special emphasis on placing in significant positions at all levels competent women and members of minority groups with whom young people may identify professionally and personally. Our record of achievement in the past year has been significant but falls short of the standard that we have set for ourselves. We are taking steps to improve our means for meeting our pledge to the Federal government and, even more importantly, to ourselves.

A second major challenge is the need to relate the university to the local and national community, to attempt a working partnership between the academy and the society which sustains it. The traditional objective, to keep at a respectable distance and avoid interference, is no longer tenable. Like many of the topics discussed in this report, the critical dynamic between the urban university and the city is interdependence. It is relatively easy to identify and even assess the needs of urban America from a perspective of some remove. Scholars have done it for decades, recently with greater sophistication and often with compassionate understanding. It is yet another matter for a university to work effectively with community organizations, from state and local government agencies to neighborhood groups and advocate interests, in the mutual effort to create an ever more decent, responsive, and responsible society.

M.I.T. should count itself fortunate for the acceptance it has had in the Cambridge community. This is, of course, the result of arduous and sensitive work on the part of many staff and students and equally of a positive response from the community and its leaders.

The total range of M.I.T.'s activities in the local community is broad and far-reaching. In both research and action modes a stream of M.I.T. men and women flow into these activities. They come from the Joint Center for Urban Studies; from the departments in the School of Architecture and Planning; from the Urban Systems Laboratory; from the School of Management; from various departments in the School of Engineering; from Political Science; from Nutrition; and from many of our other departments, laboratories, and centers as well.

In addition to these academic efforts, a variety of community service programs, which for the most part have evolved in the past few years, have been undertaken in Cambridge and Boston by students, faculty, and staff. Finally, there are many other programs conducted by M.I.T. in its role as an important institutional citizen of this metropolitan area. Many of these projects are large and substantial, and several involve collaborative action with other universities and organizations in the Boston area.

Within all these various modes of relationships, M.I.T. remains keenly aware of its central purpose to create the best possible environment for teaching and learning. Thus, the Institute has sought to become associated with community activities in ways that contribute importantly and effectively to our students, as well as to the social purposes of the activity itself. We seek to have field-linked activities provide, particularly for students, a means of adding perspective to academic studies and research. Also, we are experimenting with a number of ways of improving the educational qualities of our relations with local agencies and organizations.

The Commonwealth of Massachusetts, as well as our local Cambridge community, faces severe economic problems, many of them related to the changing social and industrial issues facing the nation. Here, too, M.I.T.'s faculty and administration have been seeking to make a contribution, both through participation in governmental activities and through the support of industrial enterprise. This participation is increasing, although it is still modest. We are optimistic about our ability to do more, particularly in helping Massachusetts make the most of science and technology in creating new industries and new jobs.

We hope the range of collaborations with our community will continue to grow to our mutual advantage, yet we recognize that there is still much to be done.

A third major challenge which we face in the months and years to come is the expansion of programs already begun, extending an M.I.T. education to people outside its usual borders, while simultaneously expanding the number and types of people who participate in the education of our students.

We have the opportunity to use modern technology as a means for reaching out beyond the classroom and the traditional limits of the educational encounter to offer greater educational opportunities to our alumni and others who might want it, as well as to our students and employees. Many members of the M.I.T. faculty and staff have been exploring the educational potential of technology for a number of years. We expect that such activities will continue, and as pilot techniques involving television, film, and computers are adopted by others at M.I.T., the advantages of technology will become as integral to education as are the current uses of books, blackboards, and lecture halls. Such technology is being used by the Center for Advanced Engineering Study in providing M.I.T. subjects in advanced and specialized areas to groups of engineers in a wide variety of organizations throughout the country. We hope that such initial efforts will grow and mature in the years to come.

Just as we can develop ways to make an M.I.T. education available to many, without limit of schedule or distance, so we hope to do the converse, to expand the range of people, institutions, and settings which can contribute to the education of those of us physically in Cambridge. Many important types of learning are not found in the classroom or laboratory — even the most fully equipped or most strongly staffed classroom or laboratory. Many of our students want to learn what it feels like to *be* an engineer; how academic principles learned in a classroom or laboratory work in the "real world;" how to test themselves against the demands of the world of work, as opposed to the world of study. They want to work with people older than themselves and younger than themselves, people whose expectations for the world may be very different from their own. Providing our students this opportunity requires investigating the possibility that organizations other than our own may be the best place for them to spend significant amounts of time; it requires collaborative arrangements with such organizations so that they are adequately compensated for their efforts in

educating our students; and it requires the development of methods to help a student grapple with his experiences and relate them to the more strictly academic part of his life.

There are several examples of initiatives taken in these directions by individuals and groups. In the past four summers, for example, we sponsored a number of urban action field projects, initiated in large measure by students and designed in most instances jointly by the participating students and the local agencies or neighborhood groups with whom the students worked in Cambridge or Boston.

The Undergraduate Research Opportunities Program (U.R.O.P.), which has been the model for effective professional involvement – on a one-to-one basis – of students and faculty on campus, was expanded this year to include opportunities off campus, where professional supervision and faculty counsel combine to provide appropriate educational experiences for students in companies, hospitals, government agencies, and other work. There is virtually no limit to the opportunities for expansion of this program, provided the basic elements of quality work and faculty supervision are present.

As this report is written, a number of new ventures of educational opportunity are under exploration. The Provost and the academic Deans are discussing the feasibility of non-regular appointments to the Faculty that would allow professionals from off campus to become clinical professors and field program supervisors with the suitable recognition and standing in the academic community that is required to facilitate and support their educational activities and contributions. There are discussions in many quarters about programs that would provide genuine career-sampling opportunities of the type afforded for years in our cooperative programs in some of the engineering departments. Clearly, more of our energy must go into activities and programs of this sort in the times ahead if we are to respond successfully to the needs of our students and of the professions. Our quality of counseling (the information, as well as the sampling of opportunities for diverse careers) must grow to reflect the demand for these services. A science-based education at M.I.T. is becoming, more and more, a suitable and desirable preparation for careers in medicine, law, and education. This requires a realistic and continuous liaison with institutions that support and utilize talent in these professions.

Improvement of internal opportunity, increased community participation, and new programs that reach outside the campus for cooperative educational arrangements are by no means the only challenges in prospect. To the individual student and the individual professor at the Institute, the outstanding challenge will always be to achieve the personal standard of performance and the personal goals that he sets for himself when he enrolls or begins to work here or, more immediately, when he enters the classroom, the library, or the laboratory every day. In annual reports that attempt to survey the macrocosm of the university, these atomistic goals and achievements tend to become submerged. But they are no less important. Indeed, it is the aggregate of these individual efforts that reflects the strength and the character of this institution. They need to be acknowledged and recognized as a primary reason for our existence.

The individual efforts and distinctions on the part of the faculty at M.I.T. have been many during the past year. Six members of the faculty were elected to membership in the National Academy of Sciences; several members of the Department of Humanities were honored with national awards for their contributions in the fields of music and literature; and faculty members in all Schools were recipients of departmental and Institute awards for both notable achievement in research and excellence in teaching. Of special note, during the year, was the appointment of Dr. Edwin R. Gilliland, Warren K. Lewis Professor of Chemical Engineering, to the distinguished ranks of Institute Professor.

The past year marked also the retirement of eleven distinguished members of the faculty. Their years of service to the Institute and to their students will long be remembered and appreciated. They are Joseph Bicknell, Professor of Aeronautics and Astronautics; Robley D. Evans, Professor of Physics; Harold W. Fairbairn, Professor of Geology; Roland B. Greeley, Professor of Regional Planning and Director of Admissions; Everett E. Hagen, Professor of Economics and Political Science and Director of the Center for International Studies; Gyorgy Kepes, Institute Professor, who continues as Director of the Center for Advanced Visual Studies; Deane Lent, Professor of Mechanical Engineering; Klaus Liepmann, Professor of Music and Director of Music; Walter McKay, Professor of Aeronautics and Astronautics; Herbert H. Uhlig, Professor of Metallurgy; and Robert S. Woodbury, Professor of the History of Technology.

ADMINISTRATION

In the fall of 1970, Howard W. Johnson announced his decision to relinquish the presidency and suggested that the trustees consider expanding the top leadership of M.I.T. This resulted in adding to the traditional presidency the post of Chancellor, as deputy to the President on all matters. As we have sought to understand and implement this new charter in our first year, we have discovered both the wisdom and the potential pitfalls of the new arrangement. Understandably, there was some duplication of effort as both of us became acquainted with our varied duties. On balance, we feel that the Institute has gained from the doubling of effort and energy. We certainly have gained a great deal of encouragement and support from each other's presence at the helm. Looking to the year ahead, we have agreed that the President will concentrate his energy on plans and strategy for the Institute's future and on efforts to secure the resources – both faculty and funding – necessary for new and continuing programs. The Chancellor will carry the general management responsibilities for all Institute programs and operations, continuing his special interests in undergraduate education and student affairs. The Provost will continue as the senior academic officer for educational programs and research, working with the academic Deans and the interdisciplinary program directors.

In concluding this report, we wish to express our deep appreciation, both as a team and individually, for the responsive understanding and support that we have received from the members of the Corporation, the Faculty, the students, the staff, the alumni, and all the M.I.T. men and

women whom we met and worked with throughout our first year in office. We are especially grateful to our administrative colleagues who have served with devotion and helped turn a difficult task into a rewarding and cheerful experience.

The past months saw several appointments to senior administrative positions that should receive special mention. Our first appointment in July, 1971, was Dean Alfred A. H. Keil to lead the School of Engineering. Dean Keil came to this post after five years as Chairman of the Department of Ocean Engineering where his vigor and imaginative plans had already begun to bear fruit with new academic curricula and a very significant Sea Grant Program, which will be formally recognized in a national convocation this fall. Professor Ira Dyer succeeded Dean Keil as Head of Ocean Engineering. In Architecture and Planning, the new Dean, William L. Porter, is a graduate of our own School where, as a Mellon Fellow and as a teacher, he has formally bridged the fields of architecture and planning in his own career.

Last spring, Dean Robert L. Bishop requested that he be relieved of his administrative duties in the School of Humanities and Social Science so that he might return to teaching and research in economics. We are fortunate to have as his successor Professor Harold J. Hanham, a distinguished historian, who will be taking up his new duties in the spring of 1973.

Professor William N. Locke stepped down from his post as Director of the M.I.T. Libraries. He continues as Professor of Modern Languages and Director of Libraries, Emeritus. In addition, he assumes the duties of Foreign Study Advisor.

Dr. Carola B. Eisenberg succeeded Professor J. Daniel Nyhart as Dean for Student affairs this past summer. Professor Nyhart served in the demanding post of the Dean with dedication and compassion, and his human qualities were much appreciated by M.I.T. students during three of the Institute's most critical years. He will continue to serve as Special Assistant to the Chancellor for preprofessional programs and as coordinator for law-related studies.

In concluding our first year in office, we owe a special debt of gratitude to the Chairman, Howard W. Johnson, and the members of the Executive Committee of the Corporation who have provided consistent and invaluable counsel and support to us on all of our activities. Finally, we wish to single out our closest colleague, Walter A. Rosenblith, who, in his new post as Provost and as a close friend and counsel, has been an essential addition to our team effort in the leadership of the Institute.

Jerome B. Wiesner
President

Paul E. Gray
Chancellor

6 October 1972

STATISTICS OF THE YEAR

The following paragraphs report briefly on the various aspects of the Institute's activities and operations during 1971-72.

Registration

In 1971-72 student enrollment was 7,717, a decrease of 82 from the 7,799 enrolled in 1970-71. This total was comprised of 4,137 undergraduate and 3,580 graduate students.

Graduate students who entered M.I.T. last year held degrees from 316 colleges and universities, 178 American and 138 foreign. The foreign student population was 1,403, representing 18 per cent of the total enrolled. The foreign students were citizens of 99 different countries.

Degrees awarded by the Institute in 1971-72 included 1,068 Bachelor's degrees, 25 Bachelor of Architecture degrees, 700 Master's degrees, 50 Master of City Planning and Architecture degrees, 117 Engineer degrees, and 418 Doctoral degrees – a total of 2,378.

The number of women at M.I.T., both graduate and undergraduate, has increased continuously. In 1971-72, 698 full-time women students were at the Institute, compared with 604 in 1970-71. In September, 1971, 128 women freshmen entered M.I.T. In September, 1970, the number was 87. In 1971-72, 137 degrees were awarded to women, compared with 108 in 1970-71.

Student Financial Aid

During 1971-72 the student financial aid program was again characterized by increases in total awards, in loans made, and in the amount of scholarship assistance. There was a small decrease in the number of individuals assisted.

A total of 2,007 undergraduates who demonstrated the need for assistance (52 per cent of the enrollment) received $2,795,982 in scholarship aid and $1,703,952 in loans. The total $4,499,934 represented no marked change in direct aid over last year.

Loans totaling $1,703,952 were made to needy undergraduates. Of this amount, $311,155 came from repayments to the Technology School Fund, $1,261,822 from the National Defense Loan Fund, and the remainder from other M.I.T. loan funds. An additional $567,965 was obtained by undergraduates from State-administered Guaranteed Loan Programs and other outside sources.

Scholarship assistance was provided by the scholarship endowment in the amount of $1,657,593, by outside gifts for scholarships in the amount of $452,538, and by direct grants to needy students totaling $539,651. Scholarship assistance from M.I.T.'s own operating funds was not used during the year. The special program of scholarship aid to minority group students represented an additional $146,200 from specially designated funds. An additional 333 students (more than twice as many as in 1970-71) received direct grants from outside agencies, irrespective of need, in the amount of $526,487. Outside scholarship support thus totaled $1,518,676, a marked increase over last year's total. The undergraduate scholarship endowment was aided by the addition of new funds which represented an increase of $693,074 and which raised the principal of the endowment to $19,801,587.

FIGURE 1

FINANCIAL AID TO UNDERGRADUATE STUDENTS
FROM ALL SOURCES, 1962-1972

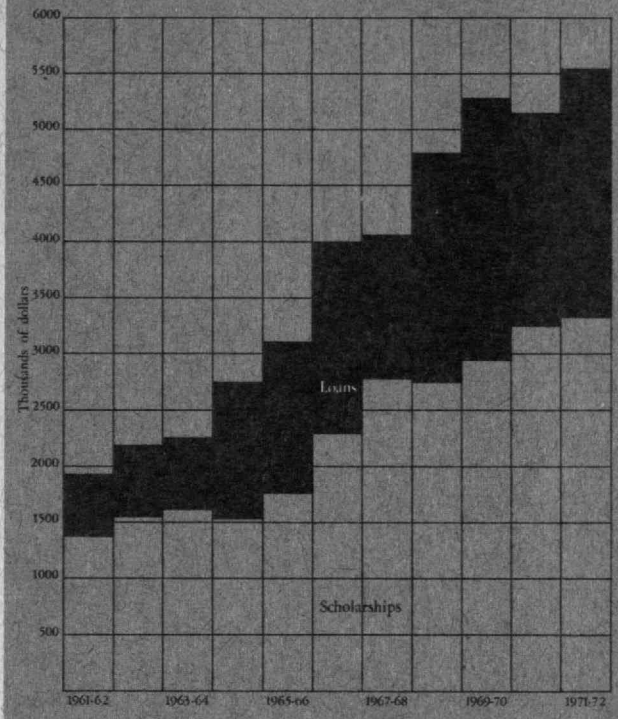
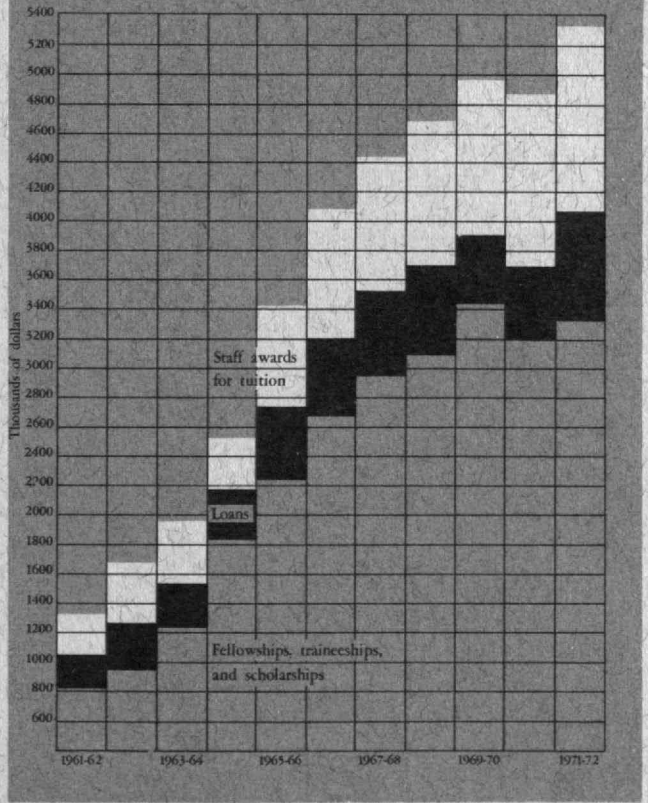


FIGURE 2

FINANCIAL AID TO GRADUATE STUDENTS
AWARDED BY M.I.T. 1962-1972



Graduate students obtained $211,501 from the Graduate Loan Fund established to provide loans at prime commercial interest rate. As a lender under the Guaranteed Loan Program, M.I.T. also made $49,004 in loans to graduate students under this program. An additional $434,685 of National Defense Loan Fund was made available to graduates this year. The total loaned by M.I.T. to 2,121 graduate and undergraduate students was $2,463,364, an increase of $335,137 over last year's total.

Placement

The economic recession, the effects of which were first felt in the 1969-70 academic year, continued to leave its mark on the work of the Career Planning and Placement Office in 1971-72. The number of companies and government agencies coming to interview graduating students dropped by 17 per cent, following a drop of 24 per cent the previous year. It was again the case that most alumni registering with the Office were out of work or feared that they soon would be. Alumni registrants totaled 710 during the course of the year, which was a significant drop from the 972 who turned to the Office for help in 1970-71, but still a high figure.

Fortunately, the last months of the year brought signs of an upturn as a number of companies which had not expected to have vacancies to fill made last-minute arrangements to recruit. A reassuring number of students had problems choosing among job offers. Companies inquiring about starting salary rates reported that they were beginning to face competition for the candidates they wanted. The drop in alumni registrations also pointed to better times.

Finances

As reported by the Treasurer, the total financial operations of the Institute, including sponsored research, increased beyond the level of 1970-71. Educational and general expenses – excluding the direct expenses of departmental and interdepartmental research, the Lincoln Laboratory, and the Charles Stark Draper Laboratory – amounted to $72,512,000 during 1971-72, compared to $71,945,000 in 1970-71. Reflected in the finances of the Institute was the decrease in the use of general purpose funds to $1,593,000, compared with $4,907,000 in the preceding year.

The direct expenses of general departmental and interdepartmental sponsored research increased from $49,015,000 to $56,467,000, and the direct expenses of major laboratories and special departmental research increased from $87,232,000 to $101,143,000.

The construction program of the Institute continued to make progress in 1971-72, with the book value of educational plant facilities increasing from $143,120,000 to $157,651,000.

At the end of the fiscal year, the Institute's investments, excluding retirement funds, had a book value of $326,482,000 and a market value of $439,596,000. This compares to book and market totals of $316,176,000 and $395,428,000 last year.

Gifts

Gifts, grants, and bequests to M.I.T. from private donors decreased from $39,637,000 for Fiscal Year 1970-71 to

$22,049,000 for Fiscal Year 1971-72. The latter figure includes unrestricted direct gifts to the Alumni Fund of $813,000, which made up a part of the total of $2,792,000 reported by the Alumni Fund in 1971-72.

Physical Plant and Campus Environment

The Burton-Conner undergraduate dormitory renovation was completed in the fall of 1971. The dormitory renovation took 14 months and involved a complete renewal of the building except for the masonry shell and the wood floors. Burton-Conner now houses 344 undergraduates in modern suite accommodations; this new style of residential living is the second facility of its type now in service on campus.

Construction of Westgate II, a high-rise residential facility on the west end of the campus, continued during the year with occupancy scheduled for fall of 1972. Westgate II will house 401 single graduate students in one-, three-, and four-bedroom apartments.

The J. B. Carr Indoor Tennis Center on Briggs Field was completed in the fall of 1971. The Tennis Center is housed in an inflatable structure that accommodates four tennis courts.

Also completed in the fall of 1971 was the George R. Wallace, Jr., Astrophysical Observatory in Westford, Massachusetts. The Observatory, made possible by a gift from Mr. George R. Wallace, Jr., Class of 1913, houses 16-inch and 24-inch telescopes.

The James and Lynelle Holden Human Biology Teaching Laboratory has been established in Building 4 where extensive renovations are currently underway. These educational facilities in human biology represent a fundamental first step in the establishment of new health sciences education and research programs at M.I.T. The Laboratory, scheduled for completion in the coming year, will be used in conjunction with the joint Harvard-M.I.T. Program in Health Sciences and Technology.

Construction continued during the year on the Electrical Engineering and Communications Research Building. The structural frame was completed in May, 1972, and the date for total completion is now forecast as June, 1973.

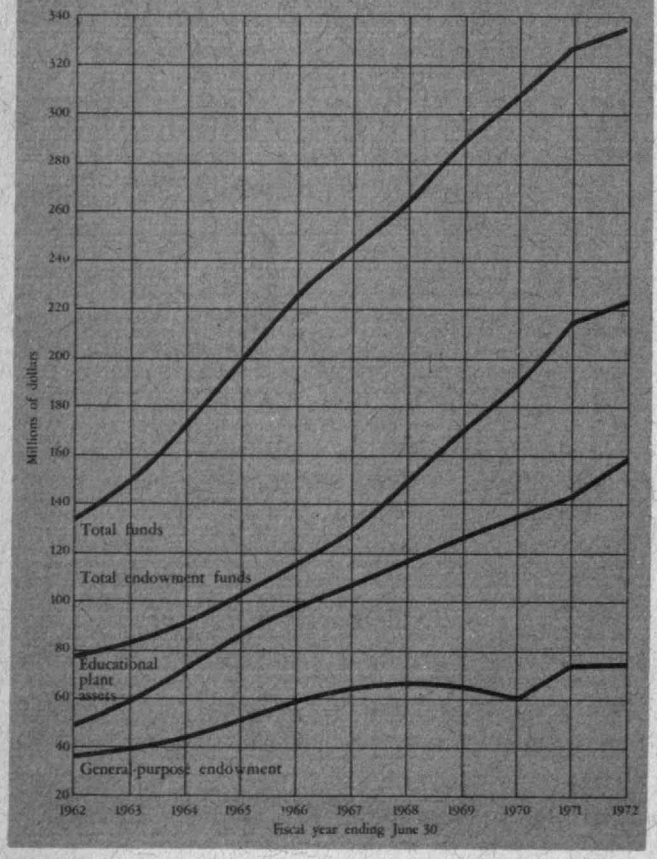
The major additions to the Central Utilities Plant are nearing completion. This will be the culmination of a three-year program to add both steam boiler and chilled water capacity, as well as to extend the campus steam distribution system, to the new West Campus housing facilities.

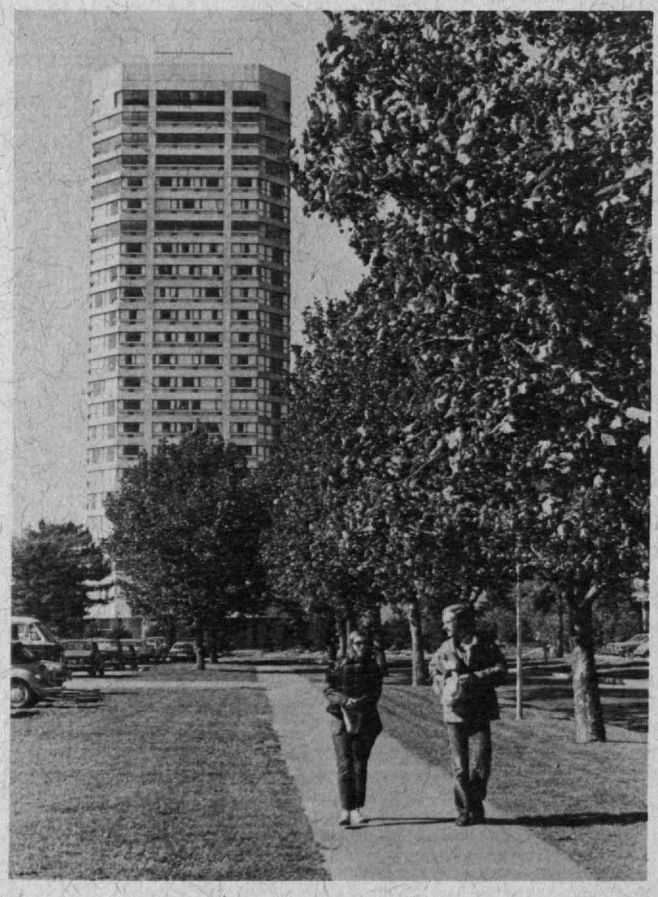
In August, 1972, the electro-mechanical telephone switch which has provided telephone service to M.I.T. for 30 years was replaced by CENTREX (central exchange), an electronic switching system. The CENTREX system, involving 8,350 telephone extensions, will provide more efficient service by enabling outside callers to reach M.I.T. offices directly rather than through a switchboard.

New projects in the preliminary design stage or under consideration include a Chemical Engineering Building, to be located to the east of the Whitaker Building; renovation of Ashdown House; renovation of a section of the Ford Building for health-related research; and additional student housing on the West Campus.

FIGURE 3

THE GROWTH OF M.I.T.'S FUNDS AND PLANT ASSETS, 1962-1972





Westgate II, a high-rise facility for graduate students is the newest addition to the west end of campus.

Institute Review

What Does the Treasurer Mean by "Positive Financial Results"?

When Joseph J. Snyder, '44, Vice President and Treasurer, calls 1971-72 a year of constructive developments, he means:

☐ Of $5.5 million available as new unrestricted funds, $2.9 million was needed to meet the operating budget. As a result, $1 million could be set aside for modernizing Ashdown House, $1.5 was transferred to endowment, and funds were available for "a substantial program of scholarships, fellowships, and student loans."

☐ Total operations of the Institute were $235.5 million in 1971-72, compared with $213.9 million in 1970-71.

☐ The costs of teaching and unsponsored research dropped to $26.9 million in 1971-72, down $1 million from 1970-71.

☐ Departmental and interdepartmental sponsored research (not including work at Draper and Lincoln Laboratories) increased—from $49 million in 1970-71 to $56.5 million in 1971-72.

☐ The market value of M.I.T.'s invested funds "improved markedly" from $395.4 million to $439.6 million, and total investment income was up to $16.9 million from $15.5 million the year before.

☐ Gifts to M.I.T. in 1971-72 were $18.4 million—down from $35.6 million in the previous year. But the difference, Mr. Snyder said, was due almost entirely to a single large receipt in 1970-71 under the legacy of K. Dexter McCormick ('04).

"University-Wide Cooperation"

These were the highlights of Mr. Snyder's annual report to the M.I.T. Corporation on October 6. "The positive financial results for the year reflected increased tuition revenues and endowment income, an expansion in government-sponsored research, early indications of the additional steps taken to control costs, and the receipt of major gifts, grants and bequests from alumni and friends of M.I.T. and from foundations and industry," he wrote.

In an earlier report to the faculty, Paul E. Gray, '54, Chancellor, presented a similarly favorable view of M.I.T. finances—at least in the short term. The demand for unrestricted funds to balance the 1971-72 operations was not only less than the previous year; it was also smaller than the amounts budgeted.

"A major reason for the downturn," said Dr. Gray, was "splendid university-wide cooperation" in a major drive for economies. Departments, laboratories, and administrative offices throughout M.I.T., he said, ended the year with unexpended balances of about $1.5 million—a figure some $400,000 larger than anyone had dared anticipate.

The reason, he expected, was that people started early to put into effect the cuts and savings which they had budgeted for 1972-73.

"Diverging Exponentials"

A few short-range problems were in Mr. Snyder's written report to the Corporation.

The Institute, he said, carries a $3 million investment in the Northgate Community Corp., organized to provide housing for faculty and students; but that Corporation "is currently showing operating losses which may depreciate the value of the debentures included in the investment portfolio." Real estate investments remaining to be developed into earning assets—notably the large tract in Cambridge formerly occupied by Simplex Wire and Cable Co.—"continued to result in a loss to current endowment income." And then there is the financial impact on M.I.T. of future divestment of the Draper Laboratory—estimated earlier this year by President Jerome B. Wiesner at $2 million in 1973-74 if present divestment plans materialize (*see* Technology Review *for October/November, p. 74*).

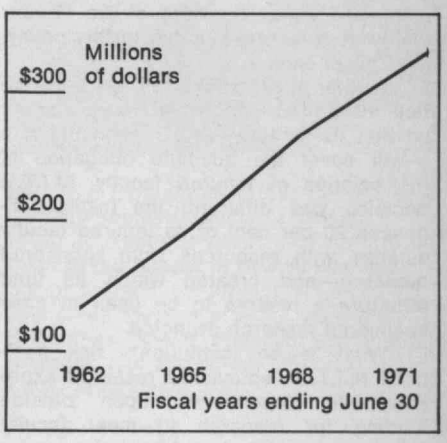
Long-range financial prospects? Keynoting the Alumni Officers Conference, Dr. Gray stressed the continuing erosion of M.I.T.'s financial strength caused by inflation. Despite skillful financial management *(see below)*, costs are rising faster than income by about $1 million a year and the difference compounds annually.

"We seem to be caught between two diverging exponentials with different time constants," he said; and to close the gap will take some real innovation—such as full 12-month utilization of plant, he said.

Don't Look in the President's Office for All the Decision-Makers . . .

. . . because one nerve center of university decision-making is now in the accounting room, said Howard W. Johnson, Chairman of the M.I.T. Corporation.

What he meant was to emphasize the role of financial management. And that has to do with a tight-rope: on one side are the resources needed now, for today's generation of students; on the other, what can be saved and invested for the students of the future. It's a "sporty course," said Mr. Johnson.



In the decade ending on June 30, 1972, M.I.T. invested funds increased from $135 million to $335 million at book value—which means that, though the Institute is more than 100 years old, two-thirds of its funds have been brought together in the past decade. The record represents a successful navigation of what Howard W. Johnson, Chairman of the Corporation, calls "a sporty course." Joseph J. Snyder, '44, Vice President and Treasurer, is confident that M.I.T. stands among private higher education "as one of the strong institutions now."

It is, indeed—as was quickly made clear by Joseph J. Snyder, '44, Vice President and Treasurer of M.I.T., who did some reading between the lines of his 1972 annual report (*see above*) for members of the Alumni Officers Conference this fall.

If you're the financial officer of M.I.T., how do you measure success? Partly this way: In the 10 years between 1962 and 1972 M.I.T.'s invested funds increased from $135 million to $335 million at book value. Mr. Snyder clearly was ready to stand on this record: though the Institute is more than 100 years old, two-thirds of the funds of M.I.T. have been brought together in the past decade.

In that 10-year period, endowment income distributed to the funds increased

to become 24 per cent (from 17 per cent) of that part of total operations financed from private resources.

What decisions made that record possible?

☐ The basic one is this: How much of added unrestricted resources should you each year put into endowment and plant —and how much use for current expenses? Mr. Snyder believes that some institutions "drifted" through the growth period of the 1960s with a management philosophy that spending proceeds at whatever pace income is available. But some institutions may now agree that "insufficient attention" was given then to careful budget projections. Throughout that period, the Executive Committee of the M.I.T. Corporation put half of M.I.T.'s new unrestricted resources into endowment, and about one-third of the 10-year endowment increase is due to this policy, Mr. Snyder said.

☐ Another sticky wicket: A few universities insist that endowment be sufficient so that its income—at a reasonable rate —will cover the absolute obligation of the salaries of tenured faculty. M.I.T.'s decision was different; the Institute finances 20 per cent of its tenured faculty salaries with resources from sponsored research—and created within its fund structure a reserve to be used in case sponsored research dwindled.

☐ What is an institution's risk position? M.I.T.'s "sponsored research exposure"—its dependence upon outside funding for research to meet faculty salaries (*see above*) and to make graduate education effective—is very great. So the Executive Committee created a research salary reserve fund, to fund tenure salaries on a long-term basis.

☐ What about investment policies? Each institution's investment plan must be sensitive to its own risk position, said Mr. Snyder; simply comparing portfolio results "on the 'total return' concept can be very misleading." Two-thirds of M.I.T. endowment funds contributed as such are invested in common stocks, 20 per cent in equity real estate, and 15 per cent in bonds. The market behavior of the 10 largest holdings in the portfolio says something about M.I.T.'s investment policy, thinks Mr. Snyder. During the 12 months ended in June, 1972, six of them outperformed such standard common-stock-market indices as Standard and Poor's. Another measure: at each quarterly period since June 30, 1969, the M.I.T. endowment investments have somewhat bettered the performance of the Standard and Poor's averages for the same dates.

"The Way We Steer Into the Future"

In summary: M.I.T. stands among private higher education "as one of the strong institutions now," said Mr. Snyder.

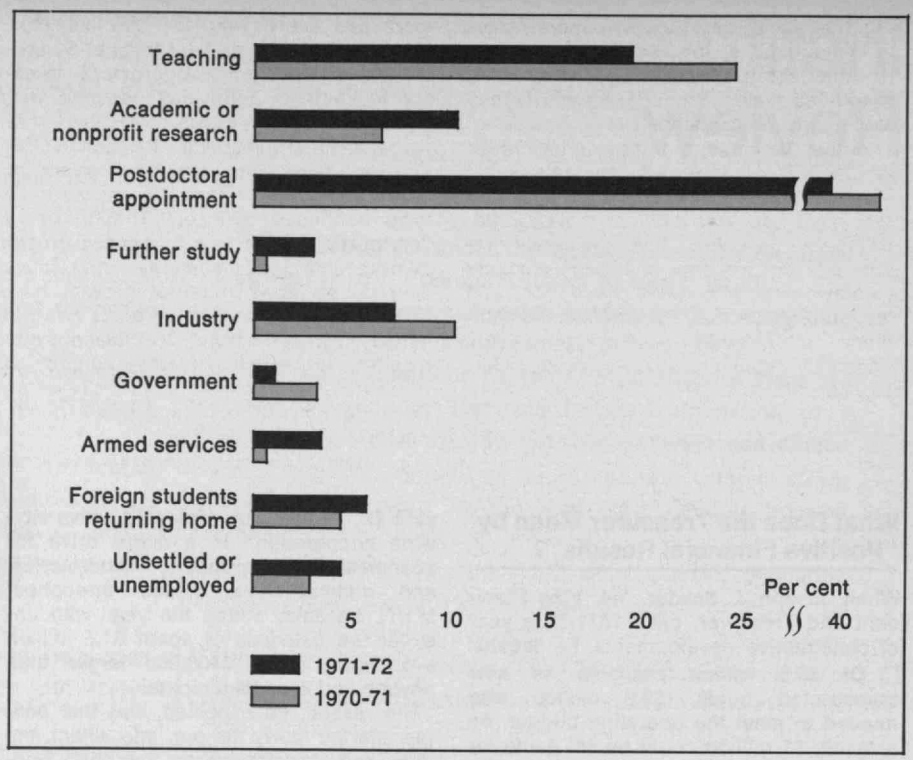
Can it stay that way?

Three things are necessary:

☐ Continue the effort "to find a better balance between revenues and expenses."

☐ Maintain a substantial flow of gifts, grants and bequests. Unrestricted gifts and grants are a "paramount" need so that "the Institute can adapt promptly and extensively to changes brought about by the advancement of knowledge, student and faculty preferences, and the needs of society."

☐ Still further perfect allocations of resources as between immediate and long-term needs and as between academic departments, endowment strategy, building expansion and maintenance, student support, and faculty tenure obligations "must be made with great insight, for these direct the way the Institute steers into the future."



Science doctorate recipients are hardest hit by the present "recessions" in the employment of scientists. The chart shows that nearly twice as many science doctorates graduating from M.I.T. reported themselves "unsettled or unemployed" as they received their degrees in 1971-72 as in 1970-71; those who found opportunities in industry dropped from over 10 per cent in 1970-71 to 7.6 per cent in 1971-72. Teaching opportunities were down, research opportunities up in 1971-72.

If You Were a Journalist Looking for a Science-Based Depression...

. . . and you came to M.I.T. to find Sc.D.'s driving taxis in 1972, "we had to disappoint you," says Robert K. Weatherall, Director of Placement. The plain fact is, he writes in his 1972 annual report, that while "many students undoubtedly had great difficulty finding acceptable jobs, unemployment among graduating students remained low."

It is news to no one that the hardest job-hunting tasks awaited graduates with doctorates in the sciences. But 1972—in contrast to 1971—was "quite a good year" for doctorates in engineering; and, says Mr. Weatherall, an even better year is just ahead.

The most critical problem of all is the small opportunity for Ph.D.'s in the sciences in industry, Mr. Weatherall says.

The statistics reveal dimensions of difficulty. As of the last information available to the Placement Office, four per cent of the 417 students who received doctorates in the year ending July, 1972, were "unsettled" as to future plans—a way of saying that they were having trouble finding jobs they wanted. A year earlier the figure was nearer three per cent. Some seven per cent of this year's master's and engineer's degree recipients were in the "unsettled" category, compared with three per cent last year. About 10 per cent of M.I.T.'s 1971-72 bachelors are shown as "unsettled"; last year it was nine per cent.

But the statistics are not an adequate report.

On the one hand, writes Mr. Weatherall, some students may have considered "radical changes" in their career plans when they found that their field was overcrowded. But on the other hand, "whatever the proposed career, students insisted on jobs in the main-stream and were not content to drift into a backwater. . . . Candidates maintained a healthy discrimination in choosing employment."

Many students, aware of the depressed job market, made plans that made them independent of company and academic recruiters. An "unprecedented number" of M.I.T. bachelor's degree recipients turned to medical school in 1972; 88 seniors out of 750 in the class graduating in June sought such admission, according to J. Daniel Nyhart, Special Assistant to the Chancellor, and 68 were admitted. Even more—92 seniors—took the tests required for law school application, and Professor Nyhart thinks the percentage accepted may have been even higher.

In the same way, Mr. Weatherall says in his annual report, there was "a noticeable increase" in the number of M.I.T. graduates taking post-doctoral fellowships and assistantships.

Another noticeable change: an increase in the number of foreign students going home after graduation. But they may in fact have had little choice; the U.S. Department of Labor has "severely restricted" the freedom of foreign students to stay in the U.S. after graduation, and the ability of U.S. companies to hire them; indeed, Mr. Weatherall writes, "domestic companies are almost totally barred to them."

"A Different Community, Different World"

The truism that technology is changing has its consequences at M.I.T., says Mr. Weatherall. When they go to look for jobs, M.I.T. graduates think less about manufacture and more about innovation, less about conventional business as an employer and more about universities and research institutions. Just over 20 per cent of all graduates took jobs in industry in 1971-72, while 39 per cent went on to graduate study or postdoctoral appointments.

Signs of the times: 369 companies came to recruit students at the M.I.T. Placement Office in 1967-68; last year only 157 conducted interviews. Five years ago 709 undergraduates signed up for one or more company interviews; in 1971-72, 307. Companies with appeal, says Mr. Weatherall, are those "seen to be breaking new ground"; the undergraduates shy away from companies whose opportunities or orientation seem to be routine.

"We're in a different community in a different world," explains Mr. Weatherall. "Image counts."

Is this an astute attitude on the part of highly qualified young graduates? Hard to be sure, but students "are highly responsive to what they take to be a bright technical opportunity," says Mr. Weatherall. And successful companies, too, are enthusiastic; "it's nice to report that they still see us as a significant source of talent."

$17,500 on Your First Job?

That's the top annual salary reported by an S.B. graduate leaving M.I.T. in 1971-72—a particularly lucky and capable senior in electrical engineering.

Omitting a few such special cases, salaries for M.I.T. graduates in 1971-72 were not very different from those in 1970-71. A few examples—median monthly salaries in 1971-72, with 1970-71 figures in parenthesis: S.M. in aeronautics and astronautics, $1,060 ($1,025); S.B. in electrical engineering, $920 ($900); Sc.D. in electrical engineering, $ 1,500 ($1,500); Sc.D. in mechanical engineering, $1,420 ($1,375); S.M. in management, $1,250 ($1,250); Ph.D. in chemistry, $1,500 ($1,315).

Hard Times: Tuition Up $200

M.I.T.'s tuition for an academic year will increase by $200 to $3,100 beginning with the 1973 Summer Session.

Tuition was $1,500 a decade ago. It has increased every year for the last four, from $2,150 to its present level of $2,900.

A letter from President Jerome B. Wiesner to students notes that "despite very sharp cuts in our budget this year, particularly in the budgets for administration and physical plant, our costs of utilities, materials, services and salaries have continued to rise." Though he is "optimistic" about new funding, even the combination of "austerity and new sources of income cannot prevent continuing tuition increases as costs rise nationally." The goal, said Dr. Wiesner, is to expand "the Institute's other sources of income so that the tuition you pay bears no more than its historical share of the cost of an M.I.T. education."

Dr. Wiesner pledged "renewed emphasis on the search for . . . new financial aid funds." And, he said, the Technology Loan Fund will be modified to take full advantage of federal programs and to provide for loan repayment rates related to future income" *(see below).*

Repayment Geared to Income: A New Phase in the Loan Fund

The Technology Loan Fund, oldest university loan fund in the U.S., is metamorphosing into Technology Loan Fund II.

The most interesting change is the adoption of a "pay-as-you-earn" plan—a loan repayment schedule geared to a graduate's increasing earning power as his job experience grows.

Under provisions of a new program effective this fall:

☐ The Fund will be compatible with the Federal Insured Loan Program whenever possible. Students will receive loans whose principal is insured—that is, whose repayment to M.I.T. is guaranteed under the federal program—up to $1,500 per student per year.

☐ The interest rate on all loans made from T.L.F. II will be 7 per cent per year. On federally insured loans, an insurance premium of 0.25 per cent will also be charged while the student is in school and principal repayment is being deferred. But under the federal program, loans for students whose parents' earnings, after deductions for taxes and dependents, fall below $15,000 will have their interest subsidized, and no interest will accrue until repayment of the principal begins nine months after graduation or termination of studies.

☐ The repayment of loans will be on a sliding scale based on the age and presumed earning power of the debtor. The amount of repayment will be 6 per cent of the estimated median income for graduates at each level of academic degree each year; as a class moves further beyond graduation, its repayment rate will increase as its earning power increases. Each borrower in a class will repay the same amount per year as his indebted classmates, and the amount borrowed will be reflected only in the number of years required for repayment of his entire loan. New schedules will be established for each graduating class.

☐ A Loan Review Board will handle problems; it may substitute lower rates of repayment, or defer repayment, for students who experience hardship or who enter low-paying fields. And it may substitute M.I.T. notes for federal loans in hardship cases where the federal repayment requirements cannot be met.

Harold J. Hanham describes himself as a "project-oriented" social scientist. When he comes to M.I.T. next April to be Dean of the School of Humanities and Social Science, his project will be to strengthen the ties at M.I.T. between humanities, social sciences, physical sciences, and technology. (Photo: David Tenenbaum, '74)

The New Dean on Humanities: "More than a Painless Veneer"

Harold J. Hanham describes himself as a "special sort of historian," the product of a high school which concentrated on mathematics and history in a sort of "project-oriented" program. He's been at it ever since, he told 400 alumni leaders attending the Alumni Officers Conference in October—and his coming to M.I.T. next spring to be Dean of the School of Humanities and Social Science will be simply another in his project series.

His project this time: to strengthen the partnership, traditional at M.I.T., between the humanities, social sciences, physical sciences, and technology.

Dr. Hanham, who is now Professor of History at Harvard, will succeed Robert L. Bishop, Professor of Economics who has been Dean of Humanities since 1964. He's ready to return to full-time teaching and research, Dean Bishop told *The Tech* this fall, because of "the feeling of having been on the job for eight years" and because he believes a social scientist has "neither the understanding nor the interest" to deal with current problems in the Department of Humanities.

Dean Hanham will also serve as Head of the Department of Humanities, succeeding Professor Richard M. Douglas.

Dr. Hanham now holds a fellowship from the Guggenheim Foundation, and he is in Europe this winter—on leave from Har-

vard—to work on a book on the culture of the Scottish highlands. He'll return to the U.S.—and come to M.I.T.—on April 1, when his new appointments become effective.

Dr. Hanham told the alumni—it was one of his only formal appearances on the campus this fall—that he recognized the humanities would always be in a minority position at M.I.T. But his hopes go far beyond "the assumption that all engineers need a small, painless veneer of culture." The challenging problem—his project, he said—is to find how to keep such a small program lively and active—finding for the humanities a role such as the social sciences of economics, political science, and psychology have already attained at the Institute.

He thinks one way will be to make the humanities more accessible, through new teaching technology—video courses, for example; another, to bring the humanities closer to engineering by making clear how really relevant human issues can be—for example, a study of how different it has been to work in factories over the last century. Such a course would be a natural part of a program on the history of technology which Dr. Hanham thinks would be "a natural" at M.I.T.

In an interview with *The Tech,* Dr. Hanham was "generally optimistic about overcoming the alleged antipathy of M.I.T. students to the humanities," wrote Lee D. Giguere, '73, and Paul Schindler, '74. To attract student interest, Dr. Hanham told them, "you've got to demonstrate that you've got something to give them that they actually want." Further, Dr. Hanham argued that "students have to go away with the idea that they have learned something."

But he dismissed one solution: "If you make courses easier, people lose what little respect they had. The process tends to become a vicious circle."

Dean Hanham is a New Zealander. He was educated at the University of New Zealand (B.A. 1948, M.A. 1950) and at Selwyn College, Cambridge University, England (Ph.D. 1954), thereafter taught for 10 years in the Department of Government at the University of Manchester before becoming Head of the Department of Politics at the University of Edinburgh; he came to his present post in 1968.

At Edinburgh, Dr. Hanham was active in developing a "modern studies" curriculum for Scottish secondary schools, and more recently he has established extensive academic and administrative connections with several African universities.

Continuity vs. Change: Keeping the Tension Truly Creative

Con'ti·nu'i·ty—the quality or state of being continuous.

Change—a substitution of one thing in place of another; any variation or alteration.

The two words are together the theme of the 1973 Alumni Fund. But even the Director of the Fund was surprised at how those words—taken later for the theme of the 1972 Alumni Officers Conference—turned out to be truly ecumenical.

It began with continuity. Opening the Conference on October 6, James R. Killian, Jr., '26, Chairman of the Corporation, embarked on a brief recital of the Institute's strengths—in faculty, students, administration and alumni, an "extraordinary team," he said, which gives him assurance "that the Institute is enormously vigorous today as it has been in the past." And Peter H. Richardson, '48, talked of "the refreshing drive to solve world problems now" that everyone in the Admissions Office sees among students who want to come to M.I.T.

"A Spirit of Flexibility"

Then came change. William T. Martin, Professor of Mathematics, insisting that despite the somewhat growing student body, "contact between faculty and students has increased in a significant way"; he cited undergraduate seminars, research opportunities, independent activities period, faculty residents and others.

"What will we be teaching to our freshmen in 10 years?" mused Robert A. Alberty, Dean of the School of Science, reporting that some 250 freshmen in the Class of 1976 completed first-term calculus before entering M.I.T., that many are in self-paced courses, that they will be in over 200 different electives by March, 1973—a "spirit of flexibility," he called it.

With all this flexibility, how can M.I.T. maintain standards? They can be even higher, thinks Dean Alberty: in a pass/fail or self-paced course, the faculty can make examinations very tough—so tough that most students flunk their first time around and then learn how really to study; a "final" is not necessarily final any more. Another view from Peter Buttner, '61, Assistant Dean for Student Affairs: M.I.T. students aren't looking for snap courses; they won't stick with something unless they're getting something out of it.

Sandra G. Yulke, '74, on being a coed: They ask, "How long have there been women at M.I.T.?" and you say, "102 years . . ." The hardest thing to overcome in getting more women at M.I.T. is the high school guidance counsellor who tries to scare women away from science and engineering.

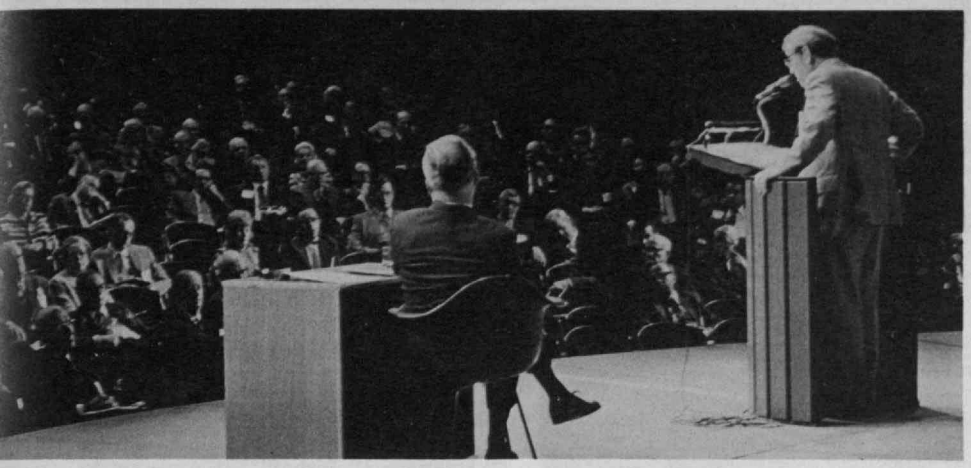
Do women come to M.I.T. to look for husbands? Groans from the audience, but think of it this way, said one alumnus: successful marriages are intellectual partnerships, too.

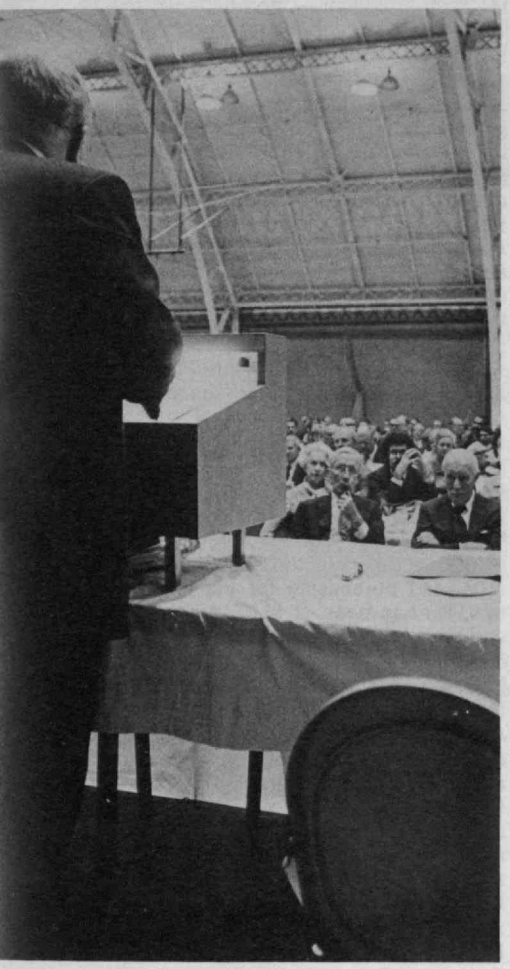
What about reorganizing M.I.T. into interdisciplinary "problem-solving" centers, instead of departments? No, thinks Shiela E. Widnall, '60, Associate Professor of Aeronautics and Astronautics. There are real advantages in keeping the disciplinary threads—so long as students can build programs relating several threads according to their interests.

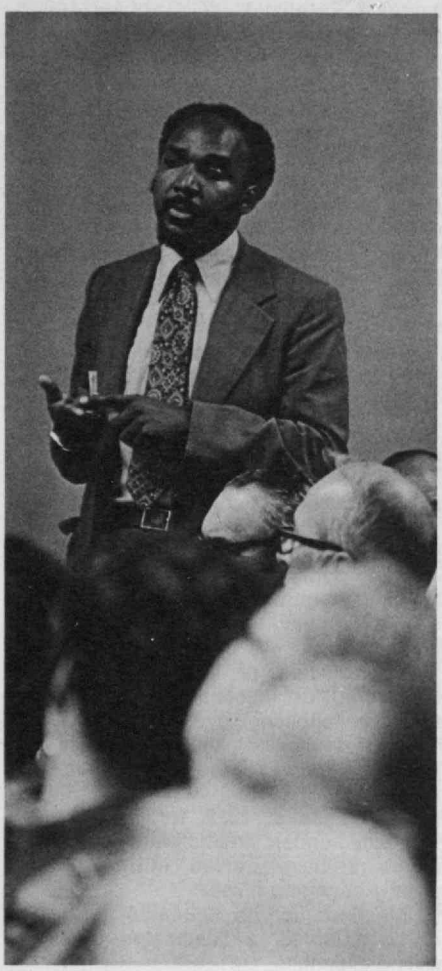
Stephan L. Chorover, Professor of Psychology: Agree. Departments are like the traditional disciplines—important as points of focus for knowledge.

Why basic research, when all students are problem-oriented? Because basic research yields a product, too—that product is knowledge. Funding for basic research? Hard. No one ever died of basic science, so how can you get money to spend on it?

Roughly 80 per cent of the members of M.I.T.'s governing bodies and committees are alumni. Here, as everywhere in the U.S., the "significant involvement" of alumni has been "an important factor in our strength," Howard W. Johnson, Chairman of the M.I.T. Corporation, told over 300 alumni at the 1972 Alumni Officers Conference. The program included President Jerome B. Wiesner's annual report (opposite, top) and an evening address by Paul E. Gray, '54, Chancellor (opposite, center left). But the feature events were the informal conversations between alumni and faculty, staff, and students about what really goes on in Cambridge. (Photos: Marc Po-Kempner from the M.I.T. News Office)







"The Situation is Discernedly Better"

Later, President Jerome B. Wiesner reported himself "surprised" when he reread the first draft of his President's Report—published in full elsewhere in this issue. It seemed to be "optimistic." But as he thinks about it, he said, yes—M.I.T.'s "situation is discernedly better."

Howard W. Johnson, Chairman of the Corporation, and Joseph J. Snyder, '44, Vice President and Treasurer, shared a discovery: "The accounting room has suddenly become a center for decision-making"—the place where short-term gain for the now generation of students is balanced against long-term gain for future generations. The problem was brilliantly illuminated by Mr. Snyder's frank discourse on financial management *(see pp. 69-70).*

Visiting Committees: No Whitewash

What happens when a Visiting Committee meets? One answer from Robert C. Gunness, Sc.D.'36, who chairs the chemical engineering committee. For the alumni leaders he paraphrased the report he gave earlier to the Corporation on October 6: the committee has identified two problem areas—How to attract new teaching talent that will restore the Department to the very top echelon of the profession, and How to get a proper balance between fundamentals and applications (in both teaching and research) when funding seems mostly available for things the chemical industry does not need?

Some of the same questions beset the Visiting Committee on the Earth Sciences, said Cecil H. Green, '23: Resist the temptation to couple the curriculum closer to practical needs, they said, for graduates' future success will depend rather on their grasp of fundamentals.

Continuity and Change

Still change: Paul E. Gray, '54, Chancellor—responding to questions at dinner on October 6: Can M.I.T. continue to increase its effectiveness? How can belt-tightening be managed? Dr. Gray makes several answers. Some of the curricular innovations are in fact less expensive than the lecture-recitation-quiz formula of the disappearing past. For example, student participation in research is a two-for-one proposition: the student learns while the research gets done. Belt-tightening, too, has been heaviest for the administration and services, lightest for academic activities.

Back to continuity: M.I.T.'s new programs "are in no way inconsistent with our determination to adhere to the essential, guiding principles of the Institute." There is, Dr. Gray said, "creative tension" between continuity and change, and "caring for one's institution today must include the resolution to preserve as well as to change it. And once a year is none too often," he said, "to say thank you" for helping to keep the tension truly creative.

Above: *Bronze Beaver winners, left to right: Springer, Davis, Loeb, Haden, Speas, Frey, Seltzer, Keyser, Wick, and Picardi.*

Left: *Presidential Citations: C. Richard Soderberg, '44, for the M.I.T. Club of Baltimore; Marvin C. Grossman, '51, for the 1972 Alumni Day Committee; and Walter P. Frey, '56, for the Educational Council of Long Island*

Beavers and Citations

Ten alumni of M.I.T. and four alumni associations and activities were honored at the Awards Luncheon of the 1972 Alumni Officers Conference on October 6. Bronze Beavers, the highest award for "distinguished service" to the Alumni Association, were given by Breene M. Kerr, '51, President, to:

☐ Ralph H. Davis, '31, for "decades of devotion to M.I.T.," culminating in service as Vice President of the Association in 1970-72.

☐ Walter P. Frey, '56, "a positive and moving force in the conduct of M.I.T. alumni activities" in the New York area.

☐ Russell L. Haden, Jr., '40, Class President, former Alumni Day Chairman, former Vice President of the Alumni Association, for "continuing interest and untiring participation."

☐ Paul V. Keyser, Jr., '29, President of the Alumni Association, 1970-72, for "decades of alumni service to M.I.T."

☐ Leo Loeb, '08, "adviser and counselor to the alumni leadership . . . and benefactor of the Institute."

☐ E. Alfred Picardi, '44, past President of three M.I.T. clubs, whose "strong sense of loyalty to the Institute . . . (has) earned you the esteem of the Institute and your fellow alumni."

☐ Max Seltzer, '18, for service to M.I.T. and fellow alumni "far beyond the formal roles and titles you have held."

☐ Charles A. Speas, '42, "Mr. M.I.T. of Baltimore."

☐ Clinton H. Springer, '45, for "a continuous record of alumni service (that) has spanned nearly three decades."

☐ Emily L. Wick, '51, for her "unique contribution to the life of the Institute . . . as advocate and model for a generation of women students at M.I.T."

There were four Presidential Citations:

☐ The 1972 Alumni Day Committee, whose "dedication, perseverance, and imaginative approach created the most delightful alumni weekend in a generation."

☐ The officers of the M.I.T. Club of Baltimore, for innovations in programs that are "challenging examples . . . (of how to) implement the concept of organized alumni service to the community."

☐ The Class of 1922, for "the distinction and understanding with which its members have served M.I.T. through greatly changing times."

☐ Members of the Educational Council of Long Island, a "dedicated cadre of willing alumni."

Romnes: Re-elected

H. I. Romnes' first term as a member of the M.I.T. Corporation expired on June 30, 1972. But his name was hardly taken off the list before it was put back: he was re-elected to a second five-year term during the Corporation's annual meeting on October 6 and thus will serve until June 30, 1977.

Mr. Romnes is Chairman of the Executive Committee of American Telephone and Telegraph Co., and earlier this year—as Chief Executive Officer of A.T. & T.—Mr. Romnes won *Saturday Review* magazine's designation as "Businessman of the Year." His long career with that company began in 1928, the year of his graduation (B.S., electrical engineering) from the University of Wisconsin, when he became a toll transmission engineer. Later assignments took him into the management of Western Electric Co. and then back again to A.T. & T. as President in 1965.

Mr. Romnes serves a number of companies and institutions as director and trustee—including most recently an assignment as President of the University of Wisconsin Research Foundation—and is a member of several committees concerned with industrial affairs.

Eleven Names Are Listed . . .

. . . for new appointments as the M.I.T. administration settles down to the job of running the Institute in 1972-73:

☐ **Laurence H. Bishoff,** '59, Assistant to the Vice President—Operations, is now at work as Assistant Director—Administration of the Medical Department. His job, says Dr. Albert O. Seeler, Medical Director, will be to plan for "a prepaid comprehensive health care program which the Medical Department hopes to offer to M.I.T. personnel next year on a limited, optional basis." Mr. Bishoff studied management at the Institute and has been Assistant to the Dean of Student Affairs and Director of Housing and Dining Services as well as Assistant to the Vice President during his 17-year Institute career.

☐ **John L. Buttrick,** Associate Professor of Music, has been chosen to succeed Klaus Liepmann as Director of Music upon the latter's retirement (*see pp. 78-79*).

☐ **William J. Duggan,** Assistant Comptroller, holds the new post of Assistant Director for Business Operations in the M.I.T. Libraries—which means he is in charge of financial control, budget, payrolls, and purchasing for the library system. He has been at M.I.T. since 1956 in various financial management assignments.

☐ **Anne Ellison,** who is completing work for a Ph.D. in psychology at M.I.T., is now Assistant Dean for Student Affairs. Her appointment comes because of a committee request for a woman in the Dean for Student Affairs office "who would have primary, but not exclusive, responsibility for women students" and "a woman's advocate" there. Miss Ellison is Canadian, studied at McGill University and taught at the University of New Brunswick, and is working with M.I.T.'s Education Research Center on an evaluation of how well M.I.T. students in new experimental teaching programs do compared with those in more conventional curricula.

☐ After 20 years with the New York City Board of Education, **Mary O. Hope** has come to M.I.T. as Assistant Dean for Student Affairs in counseling. She has worked with both young children and older adolescents in New York, and she holds a master's degree from Teachers' College of Columbia University; her daughter, Inez, is a senior in electrical engineering.

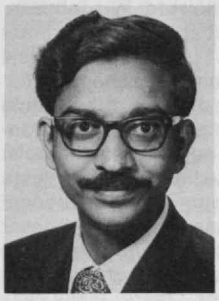
☐ **Richard A. Knight,** '47, has joined the Alumni Association as Associate Secretary; his principal assignment has to do with seminars and other continuing education programs, and he will also work

L. H. Bishoff, '59
Medical Department

Anne Ellison
Dean's Office

Mary Hope
Dean's Office

R. A. Knight, '47
Alumni Association



S. Patil, Sc.D.'70
Project MAC

C. Randall
Athletic Dept.

C. Williams
Graduate School

with alumni to support class reunion activities. Before he began a career in management consulting, Mr. Knight was for a number of years Vice President of M.S.L. Industries, Racine, Wis.

☐ **Barbara S. Nelson,** who worked part-time for the President's Office last year, now has a full-time appointment as Assistant to the President and Chancellor. The announcement says she will provide "staff support" and work on "special projects" and with the Steering Committee for the Education Division. She has studied in the Sloan School of Management and now is completing a doctorate in the Harvard Graduate School of Education.

☐ When Antony Herrey left M.I.T. to join the Ford Foundation, he turned over a series of knotty real estate management problems to **Charles D. O'Neal, Jr.,** who is now Director of the Institute's Real Estate Office. He brings more than 20 years' real estate experience to the job, having been a Project Director for the Office since 1969 and, immediately before that, Chief of Real Estate Services for the Cambridge Redevelopment Authority. In addition, two members of the Real Estate Office have become Associate Directors: **Mrs. Sheila B. Beyer,** formerly Assistant Director; and **Leigh S. Woodward,** formerly Project Manager.

☐ Project MAC, the Institute's research center on time-sharing and automatic programming for large computing systems, has a new Assistant Director: **Suhas Patil,** Sc.D.'70, Assistant Professor of Electrical Engineering. Professor Patil came to M.I.T. in 1965 for graduate study in the field, and he joined the faculty in 1970 upon finishing his doctorate.

☐ **Christine Randall** coaches women's basketball, field hockey, and softball at M.I.T., and now she is the first Director of Women's Athletics—a full-time assignment which recognizes what she says is "the need for a comprehensive women's physical education program"; a physical education requirement for graduation affects women as well as men at M.I.T. beginning with the Class of 1976. Mrs. Randall thinks that "women are not as dedicated to team sports as men," so "I just want to give the women the chance . . . to improve their skills."

☐ **Clarence G. Williams** is now Assistant Dean of the Graduate School for minority students, a position created in response to the growing numbers of such students here for graduate study, says Irwin W. Sizer, Dean of the Graduate School. "Strenuous efforts" of many at M.I.T.—including especially the Black Student Union, the Committee for Equal Educational Opportunity, and the Graduate School itself—have borne fruit: over 110 minority students—blacks, chicanos, Puerto Ricans, American Indians, and even one Eskimo—are here this year, compared with 16 in 1968, only four years ago.

From Vilno to a Three-Man Shop and a Major International Prize

That is the story of Leo M. Harvey, whose success with the Harvey Machine Co. and later Harvey Aluminum, Inc., and his interest in the Jewish people and in Technion, the Israel Institute of Technology, have now culminated in the Harvey Prize.

The Lena P. Harvey Foundation made a $1 million donation to the American Technion Society in 1971, and that fund has now been used to establish the Harvey Prizes for distinguished accomplishments in one or more of four fields: science and technology, human health, advancement of peace in the Middle East, and Middle East literature and life.

The Harvey Prize program—with $70,000 in total annual awards—was announced

President Jerome B. Wiesner (left) and Claude E. Shannon, Donner Professor of Science, were both—understandably—pleased. They were listening to the announcement of the new Harvey Prizes of the American Society for Technion—Israel Institute of Technology and Dr. Shannon's selection as recipient of one of two to be awarded in 1972. (Photo: Marc PoKempner)

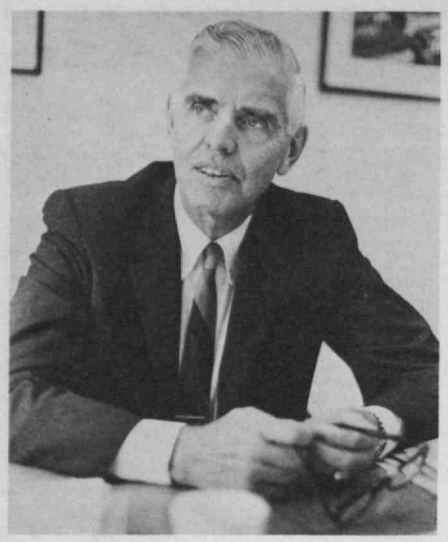
with special fanfare at M.I.T. this fall. There was an international telephone connection between the Bush Room at M.I.T., Los Angeles, Calif., and the Technion in Haifa; Jerome B. Wiesner and Alexander Goldberg, the Presidents of M.I.T. and the Technion, respectively, talked about the prizes. Dr. Wiesner recalled the "many personal and professional ties" between M.I.T. and the Technion, and Dr. Goldberg said he hoped the new prizes would "intensify our connection with the scientific community of the world."

The first two winners of Harvey Prizes were named and on the phone: William J. Kolff, Professor of Surgery and Head of the Artificial Organs Division of the University of Utah College of Medicine; and Claude E. Shannon, Donner Professor of Science at M.I.T. They each received their $35,000 awards from Zalman Shazar, President of Israel, at his home in Jerusalem on October 22.

Dr. Shannon's prize is for his "revolutionary mathematical theory of information" first published just 25 years ago. Laurence A. Tisch, President of the American Technion Society, called it a "fundamental contribution to the modern science of communication." Dr. Kolff was honored for "far-reaching achievements in the advancement of medicine" through kidney machines, heart-lung machines, cardiac assist devices, and an artificial heart as well as discoveries in transplantation.

A Unanimous Vote for James Lampert, Vice President of M.I.T.

Everyone speaks with a single voice of enthusiasm about the assignment which has been handed to James B. Lampert, S.M.'39, and the man himself, who this fall became Vice President of M.I.T.



James B. Lampert, M.I.T.'s new Vice President in the area of resource development, told members of the Alumni Association Board of Directors in October that he considers himself "one of the luckiest fellows around to have a chance to start a second career at M.I.T." (Photo: Margo Foote)

and Special Assistant to the President and Chairman in the area of resource development. Examples:

☐ Jerome B. Wiesner, President: General Lampert's appointment "will broaden our organization and augment our efforts to increase the recognition and generous support the Institute receives from its alumni and friends, from industry, and from foundations and public agencies."

☐ Howard W. Johnson, Chairman of the Corporation: "M.I.T. has been singularly fortunate over these past years in attracting the resources necessary for the development of the educational and research efforts so vital to our society. The appointment of James Lampert adds to my optimism that we will continue . . ."

☐ James R. Killian, Jr., '26, Honorary Chairman of the Corporation: "I am delighted that General Lampert is available to play a leadership role in M.I.T.'s efforts to seek new and expanded sources of funds."

General Lampert's appointment to the new vice presidency of the Institute was announced jointly by Dr. Wiesner and Mr. Johnson just before the annual meeting of the Corporation in October. He will relieve Vincent A. Fulmer, S.M.'53, Vice President and Secretary, from responsibilities in institutional development programs, leaving Mr. Fulmer to devote full time to the important work of administrative support of the Corporation and its Visiting Committees and liaison programs with industry. "Mr. Fulmer has served (in both assignments) with great loyalty and distinction," said Dr. Wiesner; and in doing so he has created "an effective organization for continued support of the Institute's development efforts."

General Lampert's military career began when he entered West Point in 1932; it culminated last summer when, as U.S. High Commissioner of the Ryukyu Islands, he turned those territories back to Japan. In between, after World War II service in the Southwest Pacific he held a large number of distinguished and responsible military posts in civil and nuclear engineering and military government: Deputy Chief of the U.S. Advisory Group in Vietnam (1958-60), Director of Military Construction (1960-63), Superintendent of the U.S. Military Academy (1963-66), and Principal Deputy Assistant Secretary of Defense for Manpower (1966-69). In the 1950s he was responsible for the Joint Army-A.E.C. Nuclear Power Program out of which came the first small, land-based military nuclear power plant.

Do We Add Water to Our Hams? Certainly Not: They're Uncle Sam's

When Ross A. Chapman retired from his job as Director-General—Food and Drugs in the Canada Department of National Health and Welfare in 1971 (he recalls it as the "most onerous, demanding, frustrating, and satisfying job in the world"), his associates wrote a poem of which the first two lines are the heading to this account.

Dr. Chapman recited the poem and described his job for the Canadian government at M.I.T. this fall as he received the $1,000 Underwood-Prescott Award for his contributions to food science and the food industry.

Recalling a 25-year history of the food industries in a society increasingly oriented to the consumer, Howard W. Johnson, Chairman of the M.I.T. Corporation, stressed Dr. Chapman's "major contributions as a regulator," developing plans "based on good science and good sense." Other speakers gave Dr. Chapman credit for avoiding, in Canada, what they referred to as excesses and inconsistencies of U.S. regulatory activity.

Mr. Johnson also announced the achievement of $650,000 in grants to M.I.T. toward a $750,000 goal for funding the Underwood-Prescott Professorship in the Department of Nutrition and Food Science. The Professorship, like the Award, is named for the late Samuel C. Prescott ('94) and William L. Underwood, who jointly, through work conducted at M.I.T., introduced the science of bacteriology to food canning. Dr. Prescott went on to head the M.I.T. Department of Biology and later to become the Institute's first Dean of Science, while Mr. Underwood continued in the company which bears his family's name.

Ross A. Chapman holds his Underwood-Prescott Award to be admired by other principals in the ceremony: Howard W. Johnson, Chairman of the M.I.T. Corporation; Samuel A. Goldblith, '40, Underwood-Prescott Professor of Food Science; and George C. Seybolt, President of the William Underwood Co.

George C. Seybolt, President of the Company, noted at the luncheon that 1972 marks the 100th anniversary of Dr. Prescott's birth and the 75th anniversary of the publication of the first joint paper by Dr. Prescott and Mr. Underwood. We continue to meet in their "spirit of collaboration between university and industry," he said, and "with their common goal of protection of the public interest."

Managing Technology? "It All Happened Kind of Suddenly"

The particular headache—if indeed there was one—that stimulated the call is not recorded. But it all began in April, 1961 when James E. Webb, Administrator of N.A.S.A., asked Howard W. Johnson, then Dean of the Sloan School of Management: What do you people know about the management of technology?

Mr. Johnson begged for a bit of time and slipped down the hall to find Donald G. Marquis, an applied psychologist who had come to the Institute two years earlier to be Professor of Organizational Psychology and Management. Professor Marquis begged for time, too—and he spent the following summer surveying the field to conclude that "there really was no such field at all—no precedents, no models, no traditions." They presently reported back to Mr. Webb, and by the spring of 1962 the Sloan School was embarking ("kind of foolishly," Professor Marquis now recalls it), with N.A.S.A. support, on research to create the new field.

Meanwhile, Richard S. Rosenbloom had just finished his doctorate at the Harvard Business School and joined the faculty there, intrigued with Harvard's interdisciplinary Program on Technology and Society and with a statement made in 1928 by David Sarnoff, who was then the perplexed manager of one of the country's pioneer technology-based enterprises: "The needs of the time will bring forth a new executive, able to understand . . ."

Dr. Rosenbloom thinks that statement may have been for Harvard what Mr. Webb's call was for M.I.T., and ever since he joined the H.B.S. faculty Professor Rosenbloom has been working on the management implications of social and technological change.

Professors Marquis and Rosenbloom were brought together at M.I.T. one day this fall to meet Robert W. Sarnoff, Chairman and Chief Executive Officer of R.C.A. They talked about their work and their interests, and Mr. Sarnoff spoke of his father's commitment to effective utilization of technology.

To symbolize their new Sarnoff Professorships in the management of technology, Robert W. Sarnoff, Chairman and Chief Executive Officer of R.C.A., gave Professors Richard S. Rosenbloom of the Harvard Business School (center) and Donald G. Marquis of the M.I.T. Sloan School of Management telegraph keys of the kind that used to be a fixture on his father's desk. The keys had built-in oscillators which Mr. Sarnoff demonstrated, but there was no evidence that either of the new Sarnoff professors had the skill with Morse code attributed to David Sarnoff, long-time R.C.A. Chairman whom the professorships honor. But Professor Marquis' face lit with pleasure when he discovered that his key contained a more relevant—if improbable—device: a cigarette lighter. (Photo: Marc PoKempner)

Then Mr. Sarnoff declared R.C.A.'s decision to formalize this new field by giving Harvard and M.I.T. each $1 million to support David Sarnoff Professorships in the management of modern technology.

The new appointments will, of course, be held by Professors Marquis and Rosenbloom, and they pledged a collaborative effort at the two schools in what William F. Pounds, Dean of the Sloan School of Management, said is an "extremely promising" program.

At a press luncheon to announce the appointments, Mr. Sarnoff waxed enthusiastic: "In my view this new program addresses the critical problem of our times: how men manage the awesome tools they have devised. Does the growing power of technology widen or narrow man's potential for its control?"

President Jerome B. Wiesner recalled for Mr. Sarnoff the "sense of special history" he felt whenever he was in David Sarnoff's presence. And President Derek C. Bok of Harvard was pleased, too: the professorships, he said, represent perhaps the best way he can imagine for the two institutions together "to create and add to knowledge on the growth and ceaseless change of technology."

Indeed, said President Bok, "the shape, nature, and interrelationships of these two institutions 25 and more years from now is perhaps the most challenging question" that he and President Wiesner share. "The scope and size of the apparatus upon which new knowledge depends" is only one of the factors which are "forcing us to think how the total effort of Harvard and M.I.T. can be made greater than the two parts."

Before coming to M.I.T., Professor Marquis had been Chairman of the Departments of Psychology first at Yale University and then at the University of Michigan; he studied at Stanford (A.B. 1930) and Yale (Ph.D. 1932). Professor Rosenbloom, whose career has been entirely at Harvard (A.B. 1954, M.B.A. 1956, D.B.A. 1960), is the author of *Technology and Information Transfer* and co-author of *New Tools for Urban Management,* and he has published widely in management and technology journals.

A Management Course To Run a Doctor's Office?

Not quite, perhaps. But health care planning and management is a legitimate professional field in the early stages of development, says William F. Pounds, Dean of M.I.T.'s Sloan School of Management; and its further development will now be the subject of a $257,000 grant from the Robert Wood Johnson Foundation of Princeton, N.J.

Three stages of an academic specialty within management were described by Dean Pounds when the Sarnoff Professorships in the management of technology (*see above*) were announced: You begin with research—at that point you really know nothing about the field so there is nothing to teach. As research yields results you put these back into more research—and you also disseminate them through seminars to students who will do more research. Finally the body of knowledge becomes formalized enough so that you can teach it in a logical, organized way.

If the management of technology has now progressed to the third of these stages, the management of health care is barely in the second. But even now, says Dean Pounds, "management researchers can make—and are making—significant contributions to improving the ways in which the nation's diverse health care systems are planned, financed, organized and managed."

David E. Rogers, President of the Foundation, cites three fundamental needs in health care which are addressed at M.I.T. —and which thus attracted the Foundation's attention: improving relations between health care workers and their patients, developing health workers as teams with group skills to solve patients' problems, and focussing these teams through health services managers whose "leadership skills" can affect "the processes of implementing organizational change."

The Johnson Foundation grant—it is the first by the Foundation to M.I.T.—will be used by Irwin M. Rubin, Ph.D.'66, and Richard Beckhard of the Sloan School staff to develop and test training programs for helping health care professions to be more effective in planning, organizing, and managing medical systems. They think the resulting training materials may be ready by early 1974.

Beginning an Undergraduate Career: The Requirements

As recently as four or five years ago, entering freshmen had no difficulty deciding what subjects to take their first year at M.I.T.—they simply copied the typical schedule from the catalog onto their registration forms.

More recently, the academic paths by which freshmen can traverse their requirements have multiplied. To help them make the academic decisions that only a few years ago were not there to be made, this year's freshman orientation included a "Core Orientation" and an "Electives Midway," enabling the Class of 1976 to speak with professors in charge of courses that satisfy requirements.

Here are the decisions the freshmen must make:

Calculus

There are two varieties—an applied approach and a classical approach—which can be begun at any of three levels, depending on the student's high-school-supplied background. In choosing, Chancellor Paul E. Gray, '54, told the entering class in Kresge Auditorium this fall, "you do not close off any options, nor do you open unique opportunities."

Professor Harvey Greenspan's pitch for his applied calculus course indicated that it was designed "expressly for M.I.T. students, taking into account their needs . . . taught by scientists for scientists . . . . Approximation is the core of all science; it is the core of this course."

Professor Arthur Mattuck seemed content to let the classical approach sell itself. But a friendly controversy arose over the question of advanced placement. Dr. Mattuck mentioned "one philosophical difference between Harvey and me"—Dr. Mattuck's suggestion that "the average student learns best when he sees new material; if he's hazy on something he can look it up."

"There's a big difference," Dr. Green-

span replied, "between taking a year of calculus and knowing calculus." The remark produced an ovation and approving laughter from the freshmen. Yet one third of the entering class has advanced placement standing in calculus.

Chemistry

For years this requirement was satisfied only by 5.01, a *guzzabuglio* of atomic structure and reaction kinetics that the Chemistry Department would rather not have taught but that the faculty insisted upon. The requirement stands but has been liberalized. Freshmen can also satisfy it by taking one of these already existing courses, though some of them require knowledge usually acquired during the freshman year:

☐ 3.091, Introduction to Solid State Chemistry, a perennial offered by the Department of Metallurgy and Materials Science.

☐ 5.41, Introduction to Structure, Bonding, and Mechanism, a Chemistry Department offering with "a strong flavor of organic chemistry."

☐ 5.60, Chemical Equilibrium, the Chemistry Department's thermodynamics course.

☐ 7.01, General Biology, offered by that Department. In the past it has been "molecular biology, not descriptive biology," but this year some population genetics and neural science have been incorporated.

Professor John Wulff was a Shakespearean actor in younger days. On stage at the Core Orientation, he launched into a dramatic speech on the making of the Great Scientist. At the words "God-given talent," his voice rose to a majestic maximum, and his dramatically outstretched hands began to tremble as if at the Great Mystery of Life itself.

But his comments soon became more practical: "If you come around tomorrow from six in the morning until six at night," he offered the more than 1,000 freshmen present, "I'll give you the lowdown—and I'll tell you how to beat the racket at M.I.T.! I've been here a long time—see the beard?—and I know what I'm talking about!"

"What's best for a chemical engineer?" came the question from the audience.

"5.41 and 5.60. Amen." replied Professor Wulff, whose field is metallurgy.

Physics

In recent years, freshman-year physics has included Newtonian dynamics and classical electricity and magnetism, with some study of special relativity.

The offerings are:

☐ 8.01 and 8.02, the traditional (that is, having a history as long as five or six years) courses, the Physics Department's first stepping stones en route to understanding the Secrets of the Universe.

☐ 8.01Z and 8.02Z, a seminar-tutorial approach.

☐ 8.011 and 8.021, meant for those who do not plan to pursue physics past the freshman year. "New in structure and content," it is taught by Professor Philip Morrison; he moves through an overview of Newtonian Dynamics, touches on a quantitative treatment, and goes onward to an historical development of astronomy and celestial mechanics. This physics sequence will end with a treatment of the general theme of energy.

☐ 8.012 and 8.022, what M.I.T. likes to call a "high-powered" approach, more overtly mathematical.

☐ 8.013 and 8.023, a biologically-oriented study of physics, for the enormous number of entering freshmen who are already certain that in four years they will be fighting for places in medical schools.

"Wait just a minute, Governor!" Was Luis A. Ferre, '24 (left, center), Governor of Puerto Rico, in Massachusetts to compete with Governor Francis W. Sargent, '39 (right, center), for the talent needed to run state government? Each joked about it with the other—and with President Jerome B. Wiesner (left) and Howard W. Johnson, Chairman of the Corporation, when the two Governors were guests of honor at the luncheon feting members of the M.I.T. Corporation on October 6. (Photo: Margo Foote)

The Governor of Massachusetts to the Governor of Puerto Rico:

"You're wasting your time here!"

"I've got news for you," said Francis W. Sargent, '39, Governor of Massachusetts, to Luis A. Ferre, '24, Governor of Puerto Rico, at the luncheon in honor of members of the Corporation following the annual meeting on October 6. Mr. Sargent noted that Governor Ferre is in the midst of a campaign for re-election, marveled that he could take time from that challenge to attend the Corporation meeting and luncheon, and had some friendly advice: go home and tend to your campaign; "Massachusetts voters don't vote in Puerto Rico."

But Mr. Ferre stayed—long enough at least to tell the luncheon guests about his technical help from M.I.T. people during his first term as Governor of Puerto Rico on three projects:

☐ Develop a system of "citizen feedback" to give Puerto Ricans a better way of communicating with the state, and vice versa (*see "Citizen Feedback: The Need and the Response," by Chandler H. Stevens in* Technology Review *for January, 1971, pp. 38-45).*

☐ Establish a Systems Analysis Center —a central data processor to serve all departments of the Puerto Rican government; for example, said Mr. Ferre, law enforcement information is now available to all police departments in Puerto Rico, and beginning this fall Puerto Ricans will renew their drivers' licenses at local terminals of the system.

☐ Organize an Institute for Social Technology, to identify potential applications —and risks—of technology to Puerto Rican social problems.

The only thing that ranks higher than technology in Governor Ferre's policy for Puerto Rico, he said, "is respect for human dignity. . . . Science must be seen as a way to obtain humanistic as well as material goals. . . . There is no loneliness in the soul if there is richness in the spirit."

When his turn came, Governor Sargent devoted his 15 minutes to a plea for government help for private educational institutions—including M.I.T. Though the 49th state in the nation in terms of per capita spending for public higher education, Massachusetts is fourth in the nation in total spending for education, both public and private, said Mr. Sargent.

The state risks "double jeopardy" from its heavy reliance on private education, he said. As the cost of private education increases, public enrollments soar and their quality is threatened while private institutions shrink and their very existence is threatened. "No longer can Massachusetts afford to be constitutionally barred from giving help," Governor Sargent declared.

Beyond Beethoven's Molecular Structure

Music lies largely outside traditional notions of how to study the humanities. On one level is "a somewhat scientized tradition," according to John Buttrick, Associate Professor of Music, in which "you study a Beethoven symphony the same way you study the molecular structure of a living organism." Beyond that lies the experience of making music.

Professor Buttrick is himself a pianist; he has performed in Europe each year since 1961. His appointment this fall to be Chairman of M.I.T.'s Music Faculty and Director of Music at the Institute may, therefore, be of more than routine interest: in the past, except perhaps in

Klaus Liepmann, who retired last June, was M.I.T.'s first Director of Music; music took its place as both academic and extracurricular program during his 25 years at the Institute. Now John L. Buttrick (left) wants to make a success even more successful. Professor Buttrick is a performer of music, and he thinks the performer's experience "of stretching your reality into an idealistic performance . . . is a very useful thing for everybody to get a whiff of." (Photo: Margo Foote)

music, a performer might have found it difficult to receive tenure at M.I.T. Professor Buttrick's selection may indicate a growing acceptance of the place of performer, composer or critic—with the scholar—in the Institute.

The music section's teaching is moving in a similar direction. This year, concert grand pianos have been acquired which will enable the music faculty to include some piano instruction in the series of music theory courses which follow an introductory course. (That introductory course now satisfies the sophomore humanities requirement.) A faculty member has been hired whose duties will include coaching student chamber music ensembles.

The department continues to present a series of concerts, including weekly noon-hour concerts at the M.I.T. chapel, and larger evening concerts at Kresge Auditorium which, though relatively unpublicized, usually attract hundreds.

For Professor Buttrick, teaching music draws upon the same resources that he uses as a performer of music; in both, "you have to communicate ideas that cannot always be measured arithmetically."

Thus the teacher's work of communication has its source in the performer's art: "There is a point at which the perfect ideal performance is something that glows in the mind, beyond anything that can be achieved in actuality. In your performance, you aim for this sort of thing. You try to stretch your reality into that idealistic performance that approaches the cosmic situation. That is perhaps a very useful thing for the scientist—I shouldn't say 'scientist', I mean anybody—to get a whiff of."

Professor Buttrick studied at the Julliard School of Music (B.S. 1957, M.S. 1959) and taught at Brandeis, Emmanuel College, and the University of Washington before coming to M.I.T. in 1967. Many alumni will remember him as the piano soloist with the Boston Pops Orchestra on Alumni Homecoming Weekends in 1971 and 1972.

Dr. Irving London's Potential for Trouble: One Job, Two Masters

He holds the first dual appointment in the history of Harvard University and M.I.T.—Professor of Medicine at both. Dr. Irving M. London has other titles as well: Professor of Biology at M.I.T., Director of the Harvard-M.I.T. Program in Health Sciences and Technology, Visiting Professor of Medicine at the Albert Einstein College of Medicine in New York, and Physician at Peter Bent Brigham Hospital in Boston.

An alumnus of Harvard (A.B. 1939) and of its Medical School (M.D. 1943), Dr. London achieved a solid reputation for research on red blood cells and diseases associated with their abnormalities and on applications of molecular biology to metabolic science—this at Columbia University, before embarking on his career in medical education and administration. In 1955 he became Chairman of the Department of Medicine at the new Albert Einstein College of Medicine and Director of Medical Services at the Bronx Municipal Hospital Center. Soon thereafter he began an involvement with M.I.T. and Harvard to plan their joint Program in Health Sciences and Technology, of which he became Director in 1970.

That Program—a collaborative effort to focus science and technology on human health needs—now claims two classes of 25 students each; they will study at both institutions and eventually receive Harvard's M.D. degree; meanwhile, Dr. London is also involved in interdepartmental biomedical engineering programs at M.I.T.

I. M. London

He holds the Theobald Smith Award of the American Association for the Advancement of Science (1953) and an honorary Sc.D. degree from the University of Chicago (1966). Dr. London is a member of the National Academy of Sciences and of the Executive Committee of its Institute of Medicine; and he is a former President (1963) of the American Society of Clinical Investigation.

You Reserved a Room? Sorry, We're Still Building It

The innkeeper's bad dream of an oversold house came to M.I.T. this fall: the freshman class was larger than expected—indeed, the largest in history; and Westgate II, the new west campus apartment tower for single graduate students scheduled for completion on September 1, was still full of workmen.

But by October 15, a month after the official opening of the term, the process of sorting out accommodations was largely completed. More students were living on the campus than ever before, and the long-time trend of increasing demand from M.I.T. students for the limited housing resources of Cambridge, Boston, and Brookline had been at least temporarily reversed.

The fraternities' rush week was successful—over 390 members of the Class of 1976 signed up. Dormitories were more popular than ever, but when the system turned out to be overcrowded by some 70 students—Richard A. Sorenson, Associate Dean for Student Affairs, admitted their quarters were "uncomfortable and unsatisfactory"—many upperclassmen elected to find Boston-area apartments. The result is that the Institute houses this year contain a higher proportion of freshmen and transfer students than ever before.

Westgate gradually came into use—the first six floors early in September, and the upper floors late in September and October, when strike-delayed elevators were finally installed. In the meantime, many Westgate reservations were honored at Ashdown House, where a program of major alterations was delayed until December 1.

Because of that program, only half of Ashdown had been scheduled for use this year: everyone will live in the east half of the building while major restoration-renewal is completed in the west half. Next year it will be the other way around. The building's entire electrical, plumbing, and heating systems are due for replacement; new bathrooms will be installed and some floor plans will be altered to make living accommodations in the building more suitable for its present occupancy. The dining room is closed this year—and presumably will be next year as well.

Ashdown House was built as the Riverside Court Apartments just as the Institute moved to Cambridge in 1916 and was acquired as a graduate student residence after World War II. The current project is the building's first major refur-

The Gallery

Fall, 1972, at M.I.T.—progressing clockwise from the picture immediately above:

☐ *Anthony Zona, Technical Instructor in Metallurgy, crafted a copper sailboat as a gift for President Jerome B. Wiesner, whose sailing prowess is not unknown in Martha's Vineyard waters.*

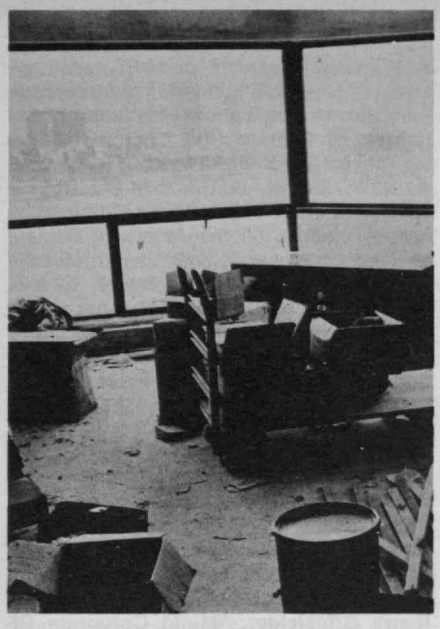
☐ *After the international championships, the Tech Coop suddenly had "tremendous" sales of chess sets and books. The picture was made on a rare warm, sunny day on the plaza just outside.*

☐ *Two days before the Eighth Annual Tuition Riot on September 12, everyone was anticipating the "spontaneous demonstration." There were shouts of "We want the Bursar!" but general good humor prevailed among all but luckless Massachusetts Avenue motorists.*

☐ *To help the competition recruit freshmen, Paul E. Schindler, Jr., '74, News Editor of* The Tech, *took to the WTBS microphone in the Building 10 lobby. Did the station's staff gain its new recruits? No report.*

☐ *"You're a Good Man Charlie Brown" opened the season for the M.I.T. Musical Theater Guild, and this picture of the cast helped sell enough tickets for a two-night standing-room-only run.*

☐ *The McDermott Scholars (among them, left to right, Martin I. Rosenberg, '73, David K. Taylor, '74, and Dwight D. Gibson, '75) were feted by Mr. and Mrs. Eugene McDermott on October 5.*



An elevator installers' strike and other contractor's problems caused frustrating delays. But the rooms in Westgate II, the new apartment tower for graduate students, turned out to be worth waiting for. The same judgment prevailed in all M.I.T. housing this fall, resulting in confusion, disappointment, waiting lists, and a high priority assigned to new campus housing. (Photo: Sheldon Lowenthal from The Tech)

bishing since it was built.

The pressure for space this fall has been sharp enough to move additional on-campus housing far up the Institute's list of unfulfilled priorities.

In Eastgate and Westgate, M.I.T. has 370 apartments for married students. The waiting list is nearly 300 names long, and no one can hope to be assigned to an apartment unless he's been on the list for at least a year.

In addition, Kenneth C. Browning, '66, Assistant Dean for Student Affairs, guesses that 200 to 250 undergraduates who are living elsewhere would like rooms on the campus if they could get them. There's a keen demand from transfer students, and the exchange program under which some Wellesley students could live at M.I.T. has been discontinued.

"If we had a new house, we'd fill it easily," he says.

Celebration with the Ladies: Miss Swallow's Centennial

Ellen H. Swallow graduated from M.I.T. in 1873, the first woman to conquer what most people assumed for most of the next century to be a man's world. It never was: since then, over 2,000 women have studied at M.I.T. and joined the Association of M.I.T. Alumnae.

Now members of the Association are completing plans for a two-day celebration of Miss Swallow's achievement a century later—on June 2 and 3, 1973. A symposium program on these two days between Commencement and Alumni Day will focus on the status of women at M.I.T. and in the professions—past, present, and future, in the U.S. and overseas.

Most details remain to be completed. But Susan E. Schur, '60, Chairman of A.M.I.T.A.'s committee, already has acceptances from Admiral Elmo Zumwalt, Chief of Naval Operations; James R. Killian, Jr., '26, Honorary Chairman of the Corporation of M.I.T.; Dorothy W. Weeks, '23; and Alice Donohue, Head of the Executive Personnel Branch, Office of Civilian Manpower Management, to participate in various forums, panel discussions, and workshops.

Other members of the committee include Anna Bailey, '54; Audrey Buyrn, '58; Mary Ellen Conway, '71; Beatrice Paipert Finn, '51; Margolia Gilson, '56; Susan L. Kannenberg, '61; Betty Ann Lehmann, '53; Maryalice Moore, CM'43; Marjorie Pierce, '22; and Shushan Teager, '54. More details later.

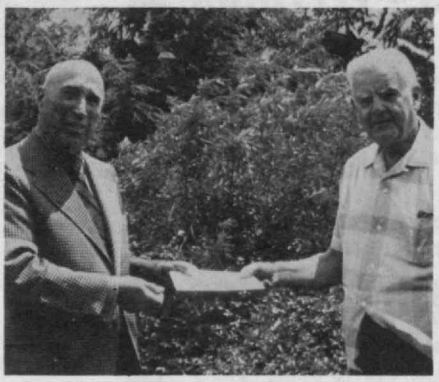
To Mexico in March

It was Karl T. Compton who recommended, 20 years ago, that the annual M.I.T. Fiesta in Mexico be restricted to 100 stateside visitors. No longer possible; the Fiesta is simply a very popular destination.

Indeed, some 75 reservations are already in for March 15, 16 and 17, 1973, in Mexico City. It will be the 25th annual Fiesta with President and Mrs. Jerome B. Wiesner as guests of honor.

Though the events will be "something special," the program itself will be much the same as in most years—tours of Mexico City, visits to Teotihuacan, the City of Gods; Chapultepec Castle; and the world-renowned Anthropology Museum. And a Noche Mexicana at the home of Mr. and Mrs. Clarence M. Cornish, '24—he is Honorary President of the M.I.T. Club of Mexico City.

There will also be post-Fiesta tours, commemorative souvenirs, and a special recognition for the class with the largest attendance. For further information write to the M.I.T. Club of Mexico City at Apartado 31, Fracc. La Florida, Edo. de Mexico, or to Herbert Weinstein, '66, who is Fiesta chairman.



Carole A. Clarke, '21 (left), has the unusual title of Executive Secretary in the U.S.A. of the M.I.T. Club of Mexico City. In the picture he's receiving his credentials from Clarence M. Cornish, '24, Honorary President of the Club; the U.S.A. secretary's principal duties are to develop interest in—and attend—the annual M.I.T. Fiesta in Mexico, which will have its 25th running on March 15, 16 and 17, 1973.

Thomas C. Desmond, 1887-1972

Thomas C. Desmond, '09, a familiar figure at M.I.T. whose interest, generosity, and public spirit touched many members of the Institute community, died in his sleep on October 7 in Boston. He was 85.

Mr. and Mrs. Desmond were in Boston for the annual meeting of the Corporation on October 6; Mr. Desmond had also attended portions of the Alumni Officers' Conference on that and the previous day. Howard W. Johnson, Chairman of the Corporation, said in a statement that Mr. Desmond, as a trustee and "valued adviser to five presidents of M.I.T.," had played "a key role in the expansion of graduate research and education and in the Institute's rise to world eminence in science and engineering."

Mr. Desmond was born in Middletown, N.Y., where his father was superintendent of a rolling mill; he graduated from Harvard *magna cum laude* in 1908 and from M.I.T. (S.B. in civil engineering) one year later. By 1930 he had made a substantial fortune as a contractor and engineer, having superintended the construction of a number of major buildings in New York City. He then put that career behind him to enter the New York State Senate from the Orange-Rockland district; and from then until 1959, when he retired, Mr. Desmond was re-elected every two years with increasing pluralities.

As a member of the Senate he sponsored legislation concerning hours and wages, medical care, housing, home rule, and benefits for aged. Even before entering the Senate he had been President of the New York Young Republican Club and Vice President of the National Republican Club.

Senator Desmond first joined the M.I.T. Corporation when he was elected President of the Alumni Association in 1931, and at the time of his death he had been a Life Member for 31 years. During this long tenure he served on committees on finance, membership, and development; and he had at various times chaired or served on Visiting Committees on architecture, civil engineering, metallurgy, mathematics, biology, and earth sciences.

Mr. Desmond's home in Balmville, N.Y., included a large private arboretum whose contents he had collected during extensive travels. His wife, Mrs. Alice Curtis Desmond, who survives him, is a noted author.

Charles E. Roihl, 1951-1972

Charles E. Roihl, '73, a fourth-year student in the Department of Architecture, died in the M.I.T. Infirmary on October 6 of complications arising from injuries in a truck-bicycle accident on September 21. He was 21.

Mr. Roihl's home was in Port Chester, N.Y., from whose high school he had entered M.I.T. in 1968. Following the accident—he was the cyclist—he had been hospitalized at Cambridge City Hospital and was transferred for recuperation at the M.I.T. Infirmary on September 28.

Charles N. Frey, 1886-1972

Charles N. Frey, former Director of the Fleischmann Laboratories and Director of Research for Standard Brands, Inc., who served as Lecturer in the M.I.T. Department of Nutrition and Food Science for 13 years beginning in 1952, died in the New York Hospital on September 27. He was 86 years old.

Dr. Frey's career in food chemistry began with the U.S. Department of Agriculture in 1912, shortly after graduation from Michigan State College. He later studied at the University of Wisconsin (M.S. 1915, Ph.D. 1920) and served in the Army Sanitary Corps before joining the Ward Baking Co. (1922-24) and the Fleischmann Laboratories, of which he became Director in 1926. His responsibilities were increased upon the formation of Standard Brands, Inc. in 1929, and it was upon his retirement as Director of Scientific Relations for Standard Brands in 1951 that he joined the Department of Food Technology at M.I.T.

Dr. Frey was widely honored in the food science profession, and his technical publications established him as a principal contributor in fermentation, microbial chemistry, and related nutritional problems.

What It's Like To Be a . . . .

. . . whatever-you-are, can now be demonstrated to M.I.T. undergraduates who want to know.

The plan is devised by G. Peter Grant, '35, Director for Clubs, and the Alumni Association's Club Council: One alternative among many in the Institute's Independent Activities Period in January will be "A day in the life of . . ." Students are now being asked to indicate a field or company in which they're interested, and alumni are being asked to volunteer to take on one or more undergraduates as observers through a full working day's routine.

The point, of course, is to let an undergraduate discover what a typical "real world" day is like in the profession or industry he is thinking of choosing for his career. Alumni willing to serve as hosts are asked to volunteer to their local M.I.T. clubs or to G. Peter Grant, Director for Clubs, M.I.T. Alumni Association.

Individuals Noteworthy

Awards and Honors: To **John M. MacBrayne,** '31, the Engineering Division Award of the Technical Association of the Pulp and Paper Industry . . . Honorary membership in the American Society of Civil Engineers to **Craig P. Hazelet,** '18 . . . the Norman Medal of the American Society of Civil Engineers to **W. David Carrier,** 3rd, '65 . . . to Army Lieutenant Colonel **Daniel L. Lycan,** '52, the Legion of Merit award . . . **Fuijio Matsuada,** Sc.D.'52, is Hawaii's Engineer of the Year for 1972 . . . to **Hermann Anton Haus,** Sc.D.'54, the American Society for Engineering Education, Western Electric Fund award . . . also from A.S.E.E., to **Jose B. Cruz, Jr.,** S.M.'56, the Curtis McGraw Award . . . to **Jerome B. Wiesner,** President of M.I.T., an Honorary Doctor of Engineering degree from Rensselaer Polytechnic Institute . . . **Patrick H. Winston,** '65, M.I.T.'s Carlton E. Tucker Teaching Award . . . to **Edward W. Merrill,** Sc.D.'47, M.I.T. Chemical Engineering Department's Outstanding Faculty award . . . the American Society of Civil Engineers' Thomas A. Middlebrooks Award to **Clyde N. Baker,** '52 . . . **Jay W. Forrester,** S.M.'45, the 1972 Award for Outstanding Accomplishment, by I.E.E.E. . . . the American Chemical Society's 1973 James Flack Norris Award in Physical Organic Chemistry to **Kenneth B. Wiberg,** '48 . . . also from A.C.S., to **John I. Brauman,** '59, the 1973 Award in Pure Chemistry.

Professional and Corporate Changes: **Robert H. Thena,** '48, to Manager of Fuels and Special Products Division of Mobil Oil Corporation International . . . **Henry Grinsfelder,** '31, to Corporate Director of Employee Health, Rohm and Haas Co. . . . **James D. McLean,** '37, to President and Chief Executive Officer of Information Machines Corp. . . . **Ward Haas,** '43, to Vice President of Corporate Research and Development of S. C. Johnson and Son, Inc. . . . **Robert B. Davis,** Ph.D.'66, to Fabric Research Laboratories . . . **James K. Littwitz,** '42, to Assistant Manager of Paper Manufacturing, Eastman Kodak Company . . . **C. Randolph Binner,** '31, to Vice President, Great Lakes Carbon Corp. . . . **William T. Wise,** '48, to General Manager, Medical Products Division of 3M . . . **Chester W. Diercks,** S.M.'62, to Corporate Vice President of Allis-Chalmers . . . **Allen G. Burgess,** '57, has joined Raytheon Co. as Manager of the Computer Systems Laboratory, Equipment Division . . . **David R. Clare,** '45, is the new Chairman of Johnson & Johnson . . . **Robert Kraay,** S.M.'57, to Vice President of Personnel and Labor Relations, Western Electric Co. . . . **M. Spalding Toon,** '40, to President, Union Railroad Company . . . **Gregory Smith,** '30, to retire as President of Eastman Gelatine Corp. of Eastman Kodak . . . **Wilbur B. Davenport, Jr.,** '43, to Director of M.I.T.'s Center for Advanced Engineering Study . . . **Richard J. Olson,** '63, has joined the Los Alamos Scientific Laboratory, Weapons Engineering Division . . . **W. Gardner Barker,** S.M.'37, to Chairman of the Board of Thomas J. Lipton, Inc. . . . **Eugene J. Michal,** '47, to Director of Climax Molybdenum Co.'s Extractive Metallurgy Laboratory in Golden, Colo. . . . **Charles J. Bates,** '57, to Technical Director of the Corn Processing Division of American Maize-Products Co. . . . **J. Paul Sanderson,** '41, to Vice President of Arthur D. Little Co. . . . **Walter A. Rutes,** '51, to Vice President of the firm of John Carl Warnecke and Associates . . . **Donald L. Hendrickson,** S.M.'50, to Environmental Affairs Associate of Mobil Oil Corporation's North American Division . . . **Shepard Bartnoff,** Ph.D.'49, to President of Jersey Central, and New Jersey Power and Light Companies . . . **Roger W. Patterson,** '44, to Program Manager in the Business and Professional Products

section of the Kodak Apparatus Division, Eastman Kodak Co.

Professional Societies: **Jordan J. Baruch,** '47, to the Science Information Council of the National Science Foundation . . . **George T. Rado,** '39, to Chairman of the Magnetism Commission of the International Union of Pure and Applied Physics . . . **H. Tyler Marcy,** '40, to President of the Instrument Society of America . . . **Robert D. Brown,** '49, to Second Vice President of the American Institute of Planners . . . **Harold Chestnut,** '39, nominated for the Presidency of the Institute of Electrical and Electronics Engineers.

Alumni Calendar

Boston—December 14, 1972, Thursday—luncheon meeting, Aquarium Restaurant. Speaker: Gyorgy Kepes, Institute Professor. Topic: Interaction of Art and Technology.—January 11, 1973, Thursday—luncheon meeting, Aquarium Restaurant. Speaker: Frank Morris, President, Federal Reserve Bank, Boston. Topic: The National Economy.

Denver—December 28, 1972, Thursday, 8:00 p.m.—Currigan Hall—evening at Pops, Arthur Fiedler conducting.

Long Island—December 5, 1972, Tuesday, 7:30 p.m.—dinner meeting, Andiron Restaurant. Speaker: Alfred Calsetta, Manager, Economic Research Department, Long Island Light Company.

Philadelphia—December 13, 1972, Wednesday, 6:00 p.m.—dinner meeting, Engineers Club. Speaker. Jeremiah P. Shea, Vice President, Commercial Loan Department, Bank of Delaware. Topic: How Does a New Venture Get Money?

Washington, D.C.—December 13, 1972, Monday, 6:00 p.m.—dinner meeting, Smithsonian Institution National Museum of History and Technology. Speaker: Cyril S. Smith, Sc.D.'26, Institute Professor.

Deceased

James A. Patch, '00, August 25, 1972
William A. Sheldon, '06, July 1, 1972
George W. Bowers, '09, July 25, 1972*
Hon. Thomas C. Desmond, '09, October 7, 1972*
Geoffrey M. Rollason, '13, August 30, 1972*
Herman A. Affel, '14, October 13, 1972
Percy F. Benedict, '14, August 5, 1972*
Col. William W. Drummey, '16, September 8, 1972
Carleton C. Adams, '17, September 7, 1972
Lawrence Davis, '17, September 13, 1972*
John Harper, '17, July 17, 1972*
L. Howard Littlefield, '17, June 7, 1972
Winfred W. Smith, '17, July 22, 1972*
Maximilian Untersee, '19, July 16, 1972*
Edgar F. Seifert, '19, September 28, 1972
Robert D. Patterson, '20, October 7, 1972
Mrs. John G. Anderson, '20, March, 1971
Raymond S. Coward, '20, August 29, 1971*
Lauren B. Hitchcock, '20, October 15, 1972
Eben H. Baker, '22, September 10, 1972*
H. Langdon Haltermann, '22, August 18, 1972*
George A. Noveck, '22, September 20, 1972
Paul Ryan, '22, August 30, 1972
Raymond P. Harold, '23, October 10, 1972
Herbert E. Wilks, '23, August 19, 1972
Berton Benjamin, '24, April 27, 1972
Carroll L. Dunn, '24, September 15, 1972
Harold P. Kurzman, '24, September 30, 1972
Ralph O. Ballentine, '25, April 2, 1972*
Allan L. Briggs, '25, June 7, 1970*
Guy C. Canfield, '25, July 30, 1972*
Grant F. Mayell, '25, August 13, 1972*
William W. Hicks, '26, June 23, 1972
Walter H. R. Cooper, '27, April 20, 1968
Eugene Herzog, '27, November 16, 1971
Kenneth J. MacKenzie, '28, August 15, 1972*
Harold E. Ford, '29, June 17, 1972*
Margaret B. Ham, '29, April 23, 1970
Trevor K. Cramer, '30, September 7, 1972
Francis C. Crotty, '31, August 20, 1972
Wendell N. Currier, '31, November, 1969
Donald L. Dunklee, '31, September 12, 1972
Robert G. Fulton, '31, July 25, 1972
Gilbert M. Roddy, '31, October 15, 1972
Samuel Waldman, '31, July 23, 1972
Robert C. Richardson, '33, October 3, 1972
J. Dyer Potter, Jr., '33, September 4, 1972*
Robert B. Mills, '33, June 5, 1972*
John B. Meakin, '35, February 23, 1972
Donald W. Kenny, '36, June 26, 1972*
Davis R. Dewey, '41, August 20, 1972
Winifred L. Erskine, '41, June 17, 1971
James K. Dun, '46, March 21, 1972
Colin A. Roberts, '46, September 6, 1972
John E. Schmidt, '48, February 17, 1972
John E. Whitman, '49, August 30, 1972
Reinaldo M. D'Oliveira, '54, July 17, 1971
James M. Ward, Jr., '68, September 19, 1972
Gary A. Fuchs, '71, January 19, 1972

*Further information in *Class Review*

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Class Review

96

A note from the daughter of **Richard O. Elliot** brought news of his continued interest in the history of ship building and that of the state of Maine. His reputation as an authority in these two fields has grown through the years, though he did get off to a poor start at M.I.T. by having his only failure in a history course!

The first frost of the year is forecast as these notes are written but by the time you read them it will be in order to wish each of you a happy Christmas.—**Clare Driscoll,** Acting Secretary, 2032 Belmont Rd. N.W., Washington, D.C. 20009

98

May Christmas bring many blessings to the four classmates of '98. Mrs. Olive Buckley, the daughter of **George Newbury,** wrote that he still lives with her in Hendersonville, N.C. and that the doctor says he is in fine shape physically. He gets up every day but has a poor memory. . . . **Alvan Davis** sold his home where he lived alone in Waterbury, Conn. and is now residing in Grove Manor at 125 Grove Street. His younger brother, Edward Davis, '01, also lives in Waterbury, at 49 Lannen Street.—Mrs. **Audrey Jones Jones,** Acting Secretary, 232 Fountain St., Springfield, Mass. 01108

04

I have no news to report for the December issue. I do wish to take this opportunity to extend holiday greetings and best wishes to you all.—**Eugene H. Russell,** Secretary, 82 Stevens Rd., Needham, Mass.

06

As we do not hear from you very often, the only news we have for this issue is bad—at least sad, with two deaths to report. **Anthony Paul Mathesius,** Course II, died July 2, 1969, probably in or near West Sayville, N.Y., and **Malcolm Bruce,** probably in Florida where he had been living for the past 15 years or so. Tony Mathesius was born June 26, 1883, in New York City, then lived in Newark, N.J. He prepared at Horace Mann High School and was in our Class although he received his degree with '07, I believe. He was prominent in class affairs, being vice president and captain of the Tug-of-War team our freshman year, class secretary and on the football team sophomore year, on the Technique Electoral Board, Associate Business Manager of '06 *Technique.* For the first two years out Tony was with the Lombard Govenor Co., in Ashland, then for a couple years with W. H. McElwain Co., in Boston. His next connection was with E. I. duPont, first in the development department as representative in their London office, and during World War I, as European manager.

After the war he was in the home office in Wilmington, Del., and by 1925 was president of International Radio Telephone Apparatus Co., in New York City, which continued to be his address until 1950 when he moved to Woodstock, Vt., for a few years, evidently in retirement. Then he returned to New York City for a few years and Sayville, N.Y., where he died. In writing to me, Tony made some timely observations on the envelope enclosing his contribution to the Alumni Fund. It was dated May 31, 1966, "You are doing an excellent job but note that those in our age bracket are mostly on fixed income, with appeals coming in from many sources, rising costs and the probability of much greater inflation, which makes husbanding our resources a necessity. Have already experienced extreme inflation—in Siberia in 1919 and in Berlin in 1922-23. It has been educational." During the six years since he made that prediction, you all know what has been going on! Tony's was a long, useful, and rewarding life. . . . Malcolm Bruce was with us only part of our first year and his name had been removed last April by order of the Alumni Office. . . . Marion joins me in All Good Wishes for Christmas and for your good health in 1973.—**Edward B. Rowe,** Secretary, Treasurer, 11 Cushing Rd., Wellesley Hills, Mass. 02181

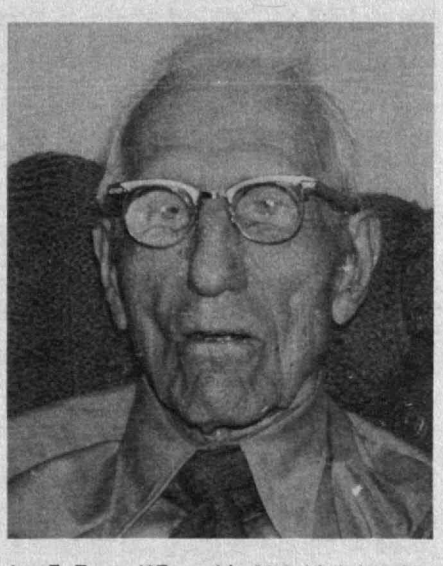
07

We have news this month of two classmates. **Milton MacGregor** was pictured in the *Sunday Herald Traveler and Sunday Advertiser,* September 10, 1972 as he ascended Mount Washington in New Hampshire. Red Mac, as he is called, climbed the 6288-foot high mountain in six hours. He first climbed it in 1911 and has made over 200 ascents since then, including climbs with each of his seven grandchildren. This makes Mr. MacGregor the oldest person to make the

Ninety-nine—And One to Go

Gordon Gammack's column in the *Des Moines Tribune* for July 8, 1972, featured a story on **Jay E. Tone** on the occasion of Mr. Tone's 99th birthday which he celebrated with his old friends—a group who call themselves "The Knights of the Round Table." Mr. Tone says that he is going to live to be 100 "and then I'm going to kiss 'em all good-by."

For 73 years Mr. Tone was associated with Tone Brothers, a family firm widely known for distribution of coffee, tea, spices and extracts. He was president of the firm for 40 years and didn't retire until he was 96. After graduating in chemical engineering from M.I.T., Mr. Tone returned to the family company and became a specialist in producing extracts, adding them to the firm's line. Mr. Tone is extremely alert, carrying on extended conversations with family and friends. "I've had a good life," he says—and now he is looking forward to that 100th birthday.—*M.K.*



Jay E. Tone, '97, on his 99th birthday. Mr. Tone attests to certain formulas for a long life. He meets with friends regularly and continues to be an avid reader.

Milton MacGregor, '07, on his way up Mt. Washington in New Hampshire. He and his daughter completed the ascent in six hours. At 88, Mr. MacGregor is hailed as the oldest person to make the climb.

ascent. He is 88 years old.

John C. Bradley was kind enough to submit some news of **Albert E. Greene** which he received from the latter's son. The letter is as follows, "Thank you for your letter inquiring about father and mother. Both of them are quite well for their age, 87 and 82 respectively. Father is rather frail but continues to endeavor to process a few remaining patent applications, with my sister's help. He is finding this almost too much, however. You may continue to address him at Box 71, Median, Wash. 98039."—**Margaret Kelly,** Class Notes Editor.

08

We are sorry to report the death of **Robert Amory,** Springs Mills Inc., on September 20, 1972, 104 W. 40th St. New York, N.Y. 10018.

Changes of address are as follows: Professor Henry W. Blackburn to 973 Lancaster Ave., Syracuse, N.Y. . . . William Roy Heilman to Watminster Village, Highway 31 So. Greenwood, In. . . . Edmund L. Warren to 69 South St., Fairfield Ct.

A visit with our class agent **Wilfred Booth** at the convalescent home—Maple Grove Manor in Norwood, Mass. found Bill in good spirits expecting to make a foliage trip to the White Mountains with his daughter.—**Joseph W. Wattles,** Secretary and Treasurer, 26 Bullard Rd., Weston, Mass. 02093

09

We regret that we were unable to provide notes for the October/November *Review.* During the summer, when the copy for the Notes was due, we were away and it is difficult to prepare them without access to the files and secretarial assistance. The six members and guests of '09 who attended Alumni Day, June 5, and the luncheon were: **Margaret Davis,** Muriel and **Chet Dawes, Tom Desmond,** Barbara and **Ben Pepper.** Within our memory, Art Shaw, our president, and Betty have never missed a reunion or an Alumni Day until this year when Betty's earlier hospitalization prevented them. We are happy to report that she is now considerably improved. Madge and **Henry Spencer** have also invariably attended all alumni and class events but this year he was not well enough to be present. Alice Desmond came to Boston with Tom but remained at their hotel since she did not feel able to participate. We all know her fame as an author and with 20 books already published, she is now writing her twenty-first—an historical novel of the Roman occupation of England. She and Tom spent several months in England researching background material for this book.

A detailed description of Alumni Day may be found in the July/August *Review,* page 88 *et seq.* An outstanding feature of the Monday morning session in Kresge Auditorium was a report by Colonel David R. Scott, A.A. '62, commander of Apollo 15, "Voyage to the Moon. . . . and Beyond." Secor D. Browne, Chairman of the Civil Aeronautics Board, followed with an address, "Commercial Aviation—A New Upturn." The usual reception for Class Secretaries by the *Review* editors was held during the morning in the Student Union. There we met John Mattill, Editor of the *Review,* who, as we have stated in a previous issue, has made it a widely circulated scientific and alumni magazine. Kathy Sayre was also there as Assistant Editor in charge of Class Notes. She has been most helpful to we Secretaries and has now been promoted to the position of Production Manager, formerly held by Brenda Kelley who has left the Institute. We also met Margaret Kelly who has taken Kathy's position and already has been helpful in preparing these notes.

At the Alumni Luncheon meeting, presided over by Paul V. Keyser, '29, President of the Alumni Association, there were talks by President Wiesner and other faculty members.

Our reports to the Class about Alumni Day have always included **Tom Desmond,** vice president of our Class, who has always contributed much to the occasion with his genial greetings to his many acquaintances among alumni and officers of the Institute. It is with the greatest regret and much sadness that we report his unexpected death on Saturday, October 7, during the Alumni Officers Conference. He, Art Shaw, and your Secretary were the members of 1909 attending. In the morning, Tom attended the meeting of the Corporation, of which he was a member, and the luncheon which followed. Shortly after five o'clock Muriel and I met him at a reception at the President's house where we discussed class affairs and material for the Class Notes including the book Alice is currently writing, and our experiences since Alumni Day. Muriel and I were most surprised and greatly shocked when on Sunday, less than two days later, we read in the Boston papers the obituary notice with prominent headlines telling of Tom's death and his illustrious career. Both Art and your Secretary have written to Alice expressing the sympathy of the Class as well as our own and urging her to continue her interest in the Class and the Institute. Because of space limitations and lack of time to obtain the necessary information for a suitable tribute to Tom, we have scheduled this for the next *Review.* Former President Howard Johnson, now Chairman of the Corporation, said: "M.I.T. and the nation have lost a brilliant friend and advocate of science and technology. A devoted alumnus and active, enthusiastic trustee, and valued adviser to five presidents of M.I.T., he played a key role in the expansion of graduate research and education and the Institute's rise to world eminence in science and engineering."

The Alumni Officers Conference, whose principal object is to keep the alumni abreast of Institute affairs, is held all day Friday and Saturday morning early in October at the time of the fall meeting of the Corporation, which also participates. This year the Conference was opened Friday, October 6, by Dr. James R. Killian, Jr., Honorary Chairman of the Corporation, who first presented his views of M.I.T.'s changing activities. He also presented the James R. Killian, Jr., Faculty Achievement Award, created by the Faculty last spring to mark his "consistent encouragement and support of professional excellence at the Institute and to express the community's affection and esteem for Dr. Killian and for his long and brilliant service to M.I.T." The first recipient of this award was Professor Nevin S. Scrimshaw, Professor and Head of the Department of Nutrition. There followed panels of speakers on such topics as the Student Body and the Faculty. At the luncheon, presided over by the new President of the Alumni Association, Breene M. Kerr, '51, the 1972 awards were presented to lead-

ing alumni officers. In the afternoon, President Wiesner gave his Annual Report and Treasurer Joseph J. Snyder, his report on Institute finances. Further presentations of Institute activities were held Saturday morning. One of the features of the Conference was a display in the Kresge lobby of many historical photographs, including one of President Rogers and others which were appreciated by us older alumni who attended the Institute when it was located in Boston.

We have received a notice of the recent death of Davis R. Dewey, 2nd, 55, of Lincoln, Mass. He was the son of Marguerite and **Brad Dewey** and a grandson of Davis R. Dewey, Professor of Economics at M.I.T. in our time. He graduated from Harvard in 1938 and received the Doctorate of Science from M.I.T. in 1941. He became vice president of High Voltage Corporation and later president of Baird Atomic, Inc. Your secretary was particularly interested in him since he took one of his courses in electrical engineering while at Harvard. We have expressed the sympathy of the Class and our own to Brad and Marguerite.

We have received two death notices from the Alumni Records Office. **Thornwell Fay, Jr.,** Course V, died November 4, 1969, at Studio City, Calif. There is little in our files regarding his career. He was initially a member of the Class of 1908 and transferred to '09 in the junior year. Our records show that he was employed by Portland cement and sulphur companies in both Houston, Texas, and Sulphur, La., spending the greater part of the time in Houston. He moved to California in May, 1967. His name does not appear in the Year Book.

George Bowers, Course I, died in Lowell, Mass., on July 4, 1972. He was well known to many of us and he attended our reunions and alumni days as long as his health permitted. He was born in 1886 and prepared for the Institute at Lowell High School. His address at the time was 359 Westford St., and except for a few of his early years, he lived at this address. We believe that he always remained a bachelor and we have no record of relatives.—**Chester L. Dawes,** Secretary, Pierce Hall, Harvard University, Cambridge, Mass. 02138.

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The letter I sent out on September 7 is bringing in results. Up to date I have received seven answers. The first I received was from **John M. Gray,** "As one of 61 surviving members of the 1910 Class, I am happy to say, outside of bad eyesight and a little lameness, my health is fairly good. Today is my 85th birthday. I now live alone; my wife passed away 12 years ago. I had four sons, all married and a total of nine grandchildren. My oldest son, John, Jr., died three years ago. He and my son Francis were partners of the John M. Gray Co., Architects. One other son, Robert, is a chemist and the other, Richard, an electrical engineer.

I started my own architectural office in 1918 and up to the time of John Jr., passing away, we have had a fairly good amount of all types of building projects. At present, our office has a small personnel which we are happy to say keeps us busy enough, as I have the excuse for still being active in the profession I love. In fact, I never had a yen to retire and I enjoy my work. My condition prevents me from doing any traveling alone. I enjoyed sea trips and a few trips to Europe for many years, so now I am limited and go away with my family and friends to the seashore and mountains in New England. Two of my grandsons served in Viet Nam: One, Richard, who was John Jr.'s son, was killed in action. The other boy, Francis' son, served two years and came home safe and sound.

To sum up, I thank God for still being active and proud to be one of 61 members of the Class of 1910, and to know that you, Herb, are still in the swim and my best to you, your family and all members of the Class of 1910."

The second letter is from John A. Holbrook's son, "My father, **John A. Holbrook,** was retired in 1963 after eight years with Voorhees, Walker, Smith and Smith and Haines subsequent to 35 years with the New York Central Railroad. He was widowed in June 1970 and has gone downhill pretty far since. Fractured left thigh and broken right hip 2½ years apart. He is now in a wheelchair and his vision, memory and hearing are pretty well gone. However, anybody who saw it would call his home "Shangri-La."

I am his middle son-unmarried-and the two of us live here solo. There is not much more I can tell you except that he can walk out to the car and loves to go for a drive, etc. He was 83 last April."

The third is from **Herman Behr,** "In reply to your inquiry as to my activities you can 'Tell 'em' that all I do is eat, sleep and drive a mile over to the shopping center to get groceries. Thanks go to my efficient wife whose loving care looks after my comfort. Oh yes, I do trim bushes once in a while but have to be careful because I'm apt to trim too short." . . . The fourth letter is from **John Barnard.** "I'm still alive but for some reason I don't have the pep in 1972 that I had in 1910." . . . The next letter is from **B. C. Huber. "Bill Hargraves,** after retiring from the Army Engineers about 1959, found that we were living in the same Morro Bay Area. When we were in Tech we camped and sailed together on Narragansett and Buzzards Bay. So the last years of his life we built a couple of sailing skiffs and sailed together on boats in this area. He was a wonderful man and friend, and loved the Wisdom of God!"

The sixth letter is from Mrs. E. H. Barber, wife of **E. H. Barber,** "My husband, I am sorry to report, is legally blind and therefore unable to reply to your request for news. Please tell the Class he has taken his blindness like a hero, enjoys good music and news via radio."

The final letter is from **George Thomas** indicating a change of address, "If it were not for you and your letter, your classmates would remain in the dark about each other and what they were doing. The fact that there are 61 survivors at this late date indicates that generally speaking we were a pretty healthy bunch.

I retired from business at age 67 and since that time have been living at our present address except that we go to St. Petersburg, Fla., to spend the winter months from November 1, until the early days of April. It seems to agree with my wife, Usas, and we are in good shape physically and recently celebrated our 61st wedding anniversary. We are blessed with three living children, eight grandchildren, and eight great grandchildren. I shall be pleased to hear from others of our classmates and know where and how they are living." George's address is 807 N. Adams St., Carroll, Iowa 51401 or after November 1, 443 Fourth Ave. N., St. Petersburg, Fla 33731, Avalou Hotel.—**Herbert S. Cleverdon,** Secretary, 35 Windmere Rd., Wellesley Hills, Mass. 02181

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Sincerest season's greetings to all Eleveners from the Class and from me. May your Christmas be glorious and the New Year be joyous.

In the Notes for July/August I said that **Frank Smith** of Honolulu was not in "robust" health. As soon as he read the Notes he got off a letter to me pleading that I tell you he is not in immediate danger of dying. I have not changed my mind about the meaning of the word "robust."

I have received from **Curtis Kinney** a present of a book by him, *I Flew a Camel,* published by Dorrance and Company, 1809 Callowhill St., Philadelphia. Besides a lively account of his experiences with the Royal Air Force in the First World War, it contains some biographical material about Curtis. After graduating in architecture from Tech he worked for a while for an architectural firm in New York. Before the United States entry into the war, Curtis tried to get into our air service but was turned down because of his hearing; so he joined the British Air Force in Canada, trained there and in England and went to France to fly a Sopwith Camel plane in combat. He was injured in a crash and earned the King George and the Victoria medals. Following the war he returned to his home town, Mt. Vernon, Ohio and joined his family department store in which he is still active as its president.

With his contribution to the Alumni Fund (Have you sent in yours?) **Edward Sisson** sent the following note: "I am still president of the American Architectural Iron Co.; though the company is really handled by my son Kenneth and son-in-law Seymour Kapston who graduated and received his master's degree from M.I.T."

In September our president, **Howard Williams,** left on a three-months tour of Europe with his wife, Katharine, and his sister-in-law. After a week in Paris they were to tour France, Spain and Switzerland by auto. Then to London and another auto trip through England, Wales and Scotland. Howard is chairman of the Board of Trustees of Pitzer College, on the Executive Board of the Los Angeles Art Center College of Design.—**Oberlin S. Clark,** Secretary, 50 Leonard Rd., North Weymouth, Mass. 02191

Members of the Class of 1912 at their 60th Reunion at Endicott House, Dedham, Mass. Foreground: The Mitchells, the Dalrymples, Mrs. Cremer, George Sprowls, Mrs. Wilson, Mrs. Brigham, Mrs. Manning, Brigham, Manning and Springall. Background: Salisbury, Cook, the Cummings, Murray, Miss Fabes, Brackett, Davis and Mrs. Springall.

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This is the first issue after that containing our reunion news. Several men have written telling what a nice time they enjoyed and complimenting Al Davis on the splendid job he did in arranging the program. The visit to Endicott House in Dedham was the highlight for many.

A letter of appreciation was received from Priscilla and **Jay Pratt,** expressing appreciation for the greeting card received from the Class. This was signed by all who attended the reunion. Their health is much better. Priscilla plays golf and Jay spent some time each day in his garden throughout the fall. . . . **Wallace Murray** has sent us a report on his trip to the Arctic which was taken last August on the *Lindblad Explorer.* He writes, "I flew to London and after a short visit, left for Norway and boarded our Arctic cruiser. It was a passenger-carrying ice breaker which had run aground last February, and had been repaired and rebuilt in Kristiand where we boarded her. First, we sailed to Tromso and then north across the Atlantic to Spitzbergen, stopping at Bjrnya and then to three islands in the eastern part of Svalbard, which is uninhabited. Here we took long walks on the tundra and muskeg. We then sailed through pack ice to latitude 82° 12′ N.

Then south to West Spitzbergen where, due to the Gulf Stream, it is warmer and less barren then the east. Here we found three permanent settlements, one with a satellite tracking station, and also saw a Russian and a Norse coal mining town, which impressed me greatly. From here we sailed to Greenland's east coast. We visited two Eskimo villages, and found them living in insulated wooden homes. They were dressed about the same as we do. Finally we travelled to Iceland and saw a beautiful botanical garden. Reykjvik is a fine small city. We sailed along the south-east coast of Greenland to Cape Farewell where we saw icebergs all around us near the Greenland ice cap. From *Kap Farvel* to St. John's, Newfoundland, we had fog all the way. Here we left the ship and I went south to Yarmouth, then took the *Prince of Fundy* to Portland, Me., and home."

Harold Brackett wrote in late August from Limerick, Me., where he planned to stay until cold weather. He and his niece, Eleanor Forbes, have kept busy with their flower and vegetable gardens. Harold says he has done little fishing since his visit to **Larry Cummings** and Julie at Squam Lake, N.H. . . . A letter was received from **Walter Slade** in Providence, R.I., reporting that he had been laid up with an operation for hernia, but that he is recovering nicely. Yes Walter, you are a tough customer, and a lucky one. . . . **Jim Cook** says that he had a good summer, though he did not get far from Marblehead. He advises that Fritz Shepard has had increased difficulty with his arthritis and spent some time in the hospital last July, where he apparently improved somewhat. Our best wishes, Fritz! Jim also says he received a visit from **Larry Cummings** and Julie this summer. . . . **Cy Springall** and Marjorie write that all is well. They said that **Jonathan Noyes** visited them on his way to his summer cottage in Maine. On our vacation we dropped in to see Jonathan and found him in good shape. His cottage in Brooklin, Me., is delightful and he cooked and served us a fine luncheon. . . . **George Sprowls** writes that all is well with him and he tries to get in a game of golf each week. He was most enthusiastic about our reunion as I know all of us who attended will agree. He says, "I hope this will not be our last reunion."

Chet Dows writes from **Cleveland** that they spent a delightful summer at their Lake Madison cottage which is not far from his home. He was given a birthday party at his cottage by neighbors and former General Electric associates. Congratulations, Chet! . . . **Ken Barnard** writes from Barnstable that he is well and still acting as chemical consultant for the Colonial Candle Co., of Hyannis. "This gives me something to do and to think about; also I can keep in touch with some of my old pals in this kind of work. I keep the afternoons as a vacation on Cape Cod." . . . **Billy Reeves** of Palmerton, Pa., writes, "Bea and I are well and are sorry we decided not to attend the reunion, which was quite a trip. I am keeping busy about the house and have been associated with the Red Cross blood program. Have also done some tripping. Cordial greetings to all my classmates who are still with us." . . . **Will Salisbury** writes to say he spent the summer at his Minnesota camp on Hungry Jack Lake as usual and had hoped that some of our classmates would have visited him. . . . Marion Lenaerts, **Jack Lenaerts'** widow, writes to say she has moved from Sarasota, Fla. to Mease Manor, a retirement home in Dunedin which is a most enjoyable location. She will be glad to see any of Jack's friends who may be in the vicinity.

We have learned that **Hamilton Merrill** who recently moved from Bridgeport, Conn., to Orleans, Mass., has recently been elected as a life member of the Board of Trustees of the University of Bridgeport, an institution in which he was interested for years. We understand Hamilton was primarily responsible for raising a development fund of over $3 million dollars. Congratulations to you, Hamilton!

I am sorry to advise of the passing of **Joseph Boyer** of Gloucester, Mass., on May 7, 1972. Although Joe only spent one year with us, he was a most loyal alumnus and advised that he was always proud to be included as a member of our Class. Our sympathy was sent to his widow.

We spent this summer in Southwest Harbor, Me., our old vacation stamping ground. Both of our daughters and six of our grandchildren were with us part of the time and we celebrated Helen's birthday there, a real party. We had hoped to take a covered bridge tour in September to Switzerland and Austria, but that was not to be. On August 30, my dear wife Helen suffered a stroke which had paralyzed her right side and affected her speech measurably. After seven weeks she had shown appreciable improvement until on October 19 she was suddenly stricken fatally with a heart attack. We had just celebrated our wedding anniversary—54 years of love and devotion with the very best person in this world.—**Ray E. Wilson,** Secretary, 304 Park Ave., Swarthmore, Pa. 19081

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Merry Christmas and Happy New Year.

We hope that you and yours are enjoying the exciting days of the 70's as we are.

We have received a very interesting letter from **Bill Brewster,** who favors on-campus 60th Reunion. He also expresses his opinions and gives his suggestions for the agenda. Shortly or maybe already you have received a bill for your 1972-1973 class dues, and an estimate of events and cost of our proposed 60th Reunion. A few weeks ago, Roz and I conferred with Fred Lehmann and his newly appointed Associate Secretary, Richard Knight. Dick has already forwarded to us considerable information and he will be helpful in furnishing more facts and figures shortly. We have received from the Alumni Office a list of 1913 classmates who have been inactive for some time: T. Dudley Ballinger, Leland S. Becker, Jacob Bernhard, Winfred S. Boynton, Harry G. Burnham, Geo. Albert Cahill, Harold S. Crocker, John L. Drummey, Dhirendra C. Gupta, and William A. Mahoney. Can any of you 1913 members furnish us with any information concerning the above as listed?

John I. Mattill, Editor of the *Technology Review* has informed us that Brenda Kelley, who lately served as the *Review*'s Production Manager has resigned to enter a new career in personnel work (we shall miss her). Kathy Sayre will step up replacing Brenda. Margaret Kelly, assistant to Kathy now, will be Assistant Editor in charge of the Class Review section. We greet the new promotions and additions to the Staff to assist our efficient editor, John Mattill.

We have received several letters from **Charlotte Sage,** our Vice President, and we are very sorry that due to previous commitments, she could not join us at the National Alumni Officers Conference at Cambridge October 6 and 7. Roz and I enjoyed the several panels and speakers. The conference was very instructive and interesting. We wish that the other officers and members of the class could have attended. . . . Via the Alumni Fund Office, we received a note from **Stanley Parker** and we quote: "I enjoy and appreciate the Class Notes—good job. Louise and I are well and living quietly in Palo Alto. We don't travel so much any more. Best regards to you and my old classmates."

Again, it is with a heavy heart that we report the death of one of our dearest classmates, **Geoffrey Rollason,** which occurred on August 30, 1972: "Geoffrey M. Rollason, for many years an executive in the metals industries, died yesterday in the Muhlenberg Hospital. He was 83 years old and lived at 935 Belvedere Ave. Mr. Rollason, who was born in Australia, came to this country as a young man. He was with the New Jersey Zinc Co. from 1913 to 1917 when he joined the army. He was with the Aluminum Casting Co. and president of the Aluminum Die Castings Corp., both Alcoa subsidiaries until Aluminum Die was merged into Alcoa. He retired in 1954. Mr. Rollason was a director and vice president of the American Die Casting Institute and served as its president in 1953. He was also a member of the American Institute of Mining and Metallurgical Engineers. He leaves his wife, the former Marguerite Stoughton." We have sent a note of sympathy to "Geof's" widow, Marguerite. We have received a very touching note expressing her appreciation.

Several changes of addresses: Mrs. Arthur Lawrence Brown, 195 St. Paul St., Brookline, Mass. 02146; Mr. Richard B. Cross, The Exeter Road, Route 108, East Kingston, N.H. 03827; Mr. Howard S. Currier, 6029 Montgomery Corner, San Jose, Cal., 95135. Have any of you classmates any definite details of William F. Herbert, 218 Palo Ave., Piedmont, Cal., 94611 or Mr. Merrill J. Smith, 3113 A, Via Serner South, 92653? Start making plans for the 60th.—**George Philip Capen,** Secretary and Treasurer, **Rosalind R. Capen,** Assistant Secretary, Granite Point Rd., Biddeford, Maine 04005

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The *Caltech News* for June, 1972, announced the establishment of the **Donald Wills Douglas** Prize Fellowship in aeronautics, to be awarded annually to finance the education in aeronautical engineering of an outstanding student selected from the United States or another country. The fellowship was initiated by Jackson R. McGowan, president of Douglas Aircraft Co., to honor the famed aviation pioneer and company founder on his 80th birthday. A total of 101 corporations, both domestic and foreign, as well as many of Don's personal friends, contributed to the fund; at the end of last May it had grown to more than $340,000. Most of the top people in the aeronautical and related industries were on hand for the birthday celebration entitled, "Around the World in 80 Years," at which the fellowship was first announced. In accepting the fellowship for Caltech, President Harold Brown praised Don as one of the great men of pioneering vision who made California a world center for the aerospace industry. "They were dreamers of dreams and leaders of men, the entrepreneurs who created giant enterprises to serve the nation and to serve mankind in its need for quick transportation and its age-old dream of flight. Donald Douglas turned his own dreams and his own inspiration, through his leadership and dedication, into institutions and products that span the entire history of the aircraft industry, from tiny single-engined airplanes through giant military and civilian aircraft to the era of men walking on the moon and of unmanned flights to the planets." After attending the U.S. Naval Academy, Don studied with us in our third and fourth years, and received his M.I.T. degree in Course II.

Bob Townend wrote in August that, instead of making his usual trip south at Eastertime to visit his daughters and their families in Atlanta and Baton Rouge, he and Maude accepted a surprise invitation to look after the Atlanta daughter's family while she and her husband took a short trip to Europe. "So we got a new airconditioned car and left for Atlanta on June 15. We were very lucky, as we got to Atlanta before the hurricane struck. We drove through Harrisburg and around Baltimore and Washington, which were badly hit. The weather in Atlanta was delightful. Our assignment was to look after the house, one grandson who had a night job, a six-month-old miniature, very lively dachshund, and one cat. Our two younger grandsons, each of whom recently won an eagle-scout award, were away at camp, and the oldest boy had a job in New Orleans. It was an interesting experience. Recently I resigned my job from the M.I.T. admissions office as an honorary secretary. I was first appointed in 1937. Both Bill Hecht and President Wiesner wrote me very congratulatory letters. I felt that the Institute should be represented by a younger man, who could tell the applicant more about M.I.T. as it is today."

Alden Waite wrote in August from Ocean Point, Me., that he and Kathryn were in the area where he had spent many summers 60 or 70 years ago, and that they had had a nice visit with Alma and **Leicester Hamilton** in Boothbay, Me. . . . **Roy Parsell** told me in August that he is still winding up his patent practice, and that he is now on the Madison (Conn.) Conservation Commission and is a member also of the Madison Property Owners Association.

Edward C. Wente died on June 9, 1972, at the age of 82, in a nursing home near his residence in Summit, N.J. After graduation from the University of Michigan, he came to the Institute and was with us during our third and fourth years; received his M.I.T. degree in Course VI, and a Ph.D. from Yale in 1918. After being with Western Electric Co. in New York, he joined the Bell Telephone Laboratories in 1934, and was with that organization in New York and in Murray Hill, N.J., until his retirement in 1954. His work was in acoustics, a field in which he was granted 36 patents. He made many important contributions to sound motion pictures, phonographs, radio broadcasting, public-address systems and television sound equipment. During World War II, his work led to the development of electrical gun-directors and air-raid warning systems. Dr. Wente's awards included the first Progress Medal of the Society of Motion Picture Engineers, in 1935, the Franklin Institute's John Price Wetherill award, the gold plaque of the Academy of Motion Picture Arts and Sciences, the John Potts Memorial Medal of the Audio Engineering Society, the Modern Pioneer award of the National Association of Manufacturers, and the Gold Medal of the Acoustical Society of America. He is survived by his wife, the former Sophia Brockman, and two sons.

Percy F. Benedict, who was with us in our third and fourth years and graduated with us in Course I, died after a brief illness on August 5, 1972, at the age of 79. He was in the U.S. Coast and Geodetic Survey for about a year after graduation, later in a General Electric laboratory in Lynn, and with the engineering firm of Buckley and Scott. For much of his career he was a teacher, and had a master's degree in education from Boston University. In 1945, Percy moved to Tilton, N.H., where he taught in the Tilton School until he retired in

1960. He was a member of Trinity Episcopal Church, in Tilton, and served as its senior warden, vestryman, treasurer, and organist. Percy is survived by his wife, the former Ellinor Clough; two sons, and seven grandchildren.

Thorn Dickinson died on August 14, 1972, after a week's illness, in a hospital in Elizabethtown, N.Y., at the age of 84. After graduating *cum laude* from Williams in 1911, he entered the Institute and received his bachelor's degree with us in Course I. He served in the army in World War I and was discharged as a captain in 1919. He was one of the first group of engineers who designed the early California freeways, and later spent three years in Greece in charge of building a new water-reservoir system for the city of Athens and similar work in Poland. His most exciting venture was on a water project and new road system in Turkey, with Stone and Webster. After retiring from the latter firm he devoted himself to writing and map-making, spending his winters in a New York hotel and his summers in the Adirondacks, until, in recent years, he lived in St. Hubert's, N.Y., and Elk Lake. Thorn was at ease in French and German, and had a unique ability to remember and quote poetry. George Makaroff, '26, who knew Thorn well, wrote of him, "He loved life, the outdoors, and bourbon, which he credited with his longevity. A born actor, he could tell a story, and make one wish for more; for he had traveled widely, and his ear would catch the curious word-music of foreign lands. He knew music and loved it from Bach to eternity, while being faithful to his own age." Our sincere sympathy goes to the families of these good classmates and old friends.

In October, the rolls of the Alumni Association included the names of 112 members of our class. . . . New address: **H. K. Chow,** Director and Secretary, New China Enamelware Co., (H.K.) Ltd., 406 Hongkong Bank Building, Mongkok, Kowloon, Hong Kong—**Charles H. Chatfield,** Secretary, 177 Steele Road, West Hartford, Ct. 06119

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At the first luncheon of The Downtown Boston Alumni on September 14, seven of our classmates attended—**Whit Brown, Viking Enebuske, Clive Lacy, Azel Mack, Archie Morrison, Wally Pike** and **The Pirate.** Ours was the largest attendance from any one class which was announced from the head table and received a round of applause. Still The Class Supreme.

Marjory and **Whit Brown** are leaving Concord, Mass., to live in Bradenton, Fla., where Whit owns a house. We'll miss Whit's cheerful and regular attendance of all our local class meetings. . . . That "old wolf", **Alton Cook** spent the winter in New Orleans and Mexico. We hope he finds whatever he is chasing down there. . . . **Larry Quirk** and his son, Charlie, have been on a long cruise down in the South Pacific. Larry wrote that the Tahitian dances were really something—and at his age! . . . **Frank Myrick** retired December 31, 1961 from Allen-Sherman-Hoff Co., Philadelphia, where he had been since January, 1922. Since his retirement he has been selling for Ash Pump Co.

Our good **Mary Plummer Rice** keeps going gayly and actively. From her home in Bronxville, N.Y., she wrote, "I've returned from three glorious months in Ireland, Paris and London by way of Plymouth as a delegate at the Mayflower Society Congress. I am planning a trip in January to visit a son in Dayton and a daughter in San Francisco on my way to a D.A.R. Washington's Birthday Celebration in Mexico City. While there I hope to attend the Twenty-Fifth Fiesta of the Mexico City M.I.T. Club. That would keep me out of the snow and ice of New York City a little longer." Isn't she wonderful!

While here last summer visiting his family, **Hank Marion** spent a pleasant afternoon with the Rooneys and the Macks and then went up to Concord to see Whit Brown. It was great to see Hank and Virginia looking and feeling so good. . . . On his way to his grandson's wedding in Maine this September, **Jim Tobey** stopped to visit with me and to check on how I shall use some class funds for our next winter's cruise. Ah me—what a guy. Jim looks the same as he did in school days. I hope you all realize how rewarding it is for me to see classmates who stop in Boston. These pleasant and nostalgic visits renew and preserve our fine friendships. We're all "getting on." . . . **Pop Wood** was in a lawn bowling tournament at Randy Spalding's, '22, "Spalding Inn Club" at Whitefield, N.H. What an athlete! . . . Next month's column will carry the story of our Boston Class Lunch, October 13 at the M.I.T. Faculty Club.

I have a copy of *The Tech* of January 11, 1913. On the staff were **Bert Adams,** Business Manager; **Homer Rogers,** Societies Editor; Pete Munn, Exchange Editor; **Sam Berke,** Ted Burkhart and **Eastie Weaver,** News Staff; and Lindsey Lamb, Business Board.

The yellowed pages describe an indoor track meet with 1914 beating out '13, '15 and '16. Time marches on! Compare these times and distances with the present-day records in parentheses: 35-yard dash, H. S. Wilkins, '14, 4 secs.; 440-yard dash, J. Bolton, '14, 59 secs. (44.7 secs.); 880-yard run, **C. T. Guething,** 2 min. 13-2/5 secs. (1 min. 44.9 sec.); mile run, H. S. Benson, '16, 4 min. 59-4/5 secs. (3 min. 51.1 sec.); high jump, J. H. McKinnon, '14, 5 ft. 7-3/4 inches (7 ft. 6-3/4 in.). 16 lb. shot-put, R. J. Favorite, '14, 33 ft. 8 in. (71 ft. 5-1/2 in.); pole vault, L. Lauranson, '16, 9 ft. 6 in. (18 ft. 1/4 in.).

The sympathy of our Class goes to **Max Woythaler** and his family for the sad loss of his wife Katherine, who died September 21, after a long illness. With Max she attended our Class Cocktail party and dinners here each year. We were always glad to see her and enjoyed having her with us. Barbara Thomas and a class representative attended her services at St. Andrews Episcopal Church in Framingham. . . . And our sympathy to **Ray Stringfield,** whose wife, Margaret, died in Los Angeles in June. We feel deeply for these fellows.—**Azel W. Mack,** Secretary, Apt. 26A, 100 Memorial Dr., Cambridge, Mass. 02142

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Many varied regrets have been expressed regarding inability to attend the reunion in June. The **Mellens** expected to be in California, the **Art Shueys** in Puerto Rico, the **Dan Comiskeys** in Dublin and **Rudi Gruber** in Germany. . . . Post-reunion letters included one from the **Walt Bingers** saying they had a grand time in France and Italy; one from **Charlie Cellarius** vowing to attend the 57th next year assuming no conflict with the 60th reunion of his Yale class of 1913 in New Haven; and one from **Mac McCarthy** regretting his and Betty's absence but noting that all '16ers in the reunion picture "look hale and hearty—defying the assaults of time."

As we write, we understand that in November **Frank Ross** is going to Hawaii with the American Seniors Golf Team to play the Japanese and Hawaiian Seniors. How about that for our old-time golf champion! Frank expects to play for about a week in the tournament and then spend a week or so seeing the other islands. How shall we answer this proposition of Frank's: "If you'll promise to get it filled out properly at the next reunion, I'll send you a grass skirt!"

We received copies of an article in the August 27 issue of the *Sunday Herald Tribune.* The headline quickly tells all: "The World of Aviation—At 78, Flying is Still Isidor Richmond's Bag." A bright picture of Izzy has a caption, "**Isidor Richmond,** shown here in the familiar surroundings of airplanes, is 78 years old and still flying. A Boston architect, he feels that flying helps keep him young and that the country is losing a lot of good talent by retiring people at 65. 'Retirement is for the birds,' he says, and believes that flying has also helped him in business." We read among other things: "The slightly-built white-haired architect doesn't see anything remarkable about his flying. To him, being an active pilot at 78 goes along with his philosophy about age generally. Actually, quite a few fliers nationally seem to share Richmond's credo. As of last July 31, according to the Federal Aviation Administration, there were five pilots 85 years of age or older, and 43 between 80 and 84 (airline pilots must retire at 60)." As an aid in business, Izzy says, "While people may have a certain image of a man 78, they are likely to reconsider when confronted by a vigorous individual who drops in on them by plane."

And when we say of Izzy, "What a guy!", here's another one. **Dave Patten** writes, "Doing fine," a remarkable thing to be able to say with his recovery from a broken neck, suffered when he fell from a stepladder back in June. Envying Izzy just a bit, Dave recalls his early flying lessons spending his luncheon hours at Logan after World War I, his piloting of DC-47's in the Aleutians, and flying a Lockheed Loadstar across the Alaskan gulf to the discomfort of

passengers. . . . **Charlie Lawrance** tells of his and Lois' visit with Dorothy and Dave in Duxbury. Charlie reported Dave as vigorous and forceful, minus the horse collar he has used for immobilization and healing, with just a bit of a stiff neck as the only evidence of what he had been through. Charlie tells of many delightful visits of children and grandchildren during the summer, adding that "the old house vibrated and bulged, but stood up to it all." Many of us know just what he means.

Van Bush scores twice in our current incoming mail. The first is a sparkling review of his book *Pieces of the Action,* in a recent issue of *Tomorrow Through Research* of the Southwest Research Institute. Reading just a few comments on what Van has to say about organizations, stumbling blocks and tyros is enough to make anyone, not just '16ers, beg, borrow or buy a copy of the book. The second item appeared in the June 4 issue of the Sunday *New York Times,* under the heading of "Patents That Expire," with the photographs of three inventors, Van, Luther Simjian and William Shockley. We read: "Of the 600 patents expiring next Wednesday, one covers a hydrofoil control invented by Dr. Vannevar Bush and Paul A. Scherer, respectively president and chief executive officer of the Carnegie Institute of Washington. Both are now retired but their invention is still operable and is in use by the navy." . . . At the end of May, Research Foundation announced that the 7th Annual **Joseph Warren Barker** Fellowship in Engineering would be offered for a nominal one-year period beginning July 1, 1973. The fellowship is named for our Joe, a member of the Board of Directors of Research Corporation since 1934, and President and Chairman from 1945 to 1959. As noted, "Barker Fellows in past years have represented such fields as flight transportation and management, chemical engineering, electrical engineering, applied mechanics, and space engineering." . . . Our retired but busy Iowa State University professor, **Herb Gilkey,** declares that the 56th reunion class picture is a winner—"cannot imagine a finer, better-preserved group." Says his grandchildren range in age from 16 to 25—a very satisfactory lot." "Walk to the office (a mile each way) two or three times weekly (or should I say 'weakly'?), but admittedly I accomplish little. Warm regards to all."

Did you ever think of going back to college and taking a post-graduate floating course all over the Pacific? That's what Virginia and **Joel Connolly** did on the *SS Universe Campus,* starting in June from Los Angeles and returning in September on one of the three 1972 courses for which the ship is chartered by Chapman College in Orange, Calif. Shades of *Mutiny on the Bounty,* they passed through the Bligh entrance of the Great Barrier Reef, so named for Captain Bligh, who discovered it in 1789 on his way to capture his mutineers. We had word from our two students from the Arafura Sea, just west of the Torres Strait that separates New Guinea from Australia, where Joel says there is an unusual range of tide at the two ends—that at the western end (Indian Ocean) is twice as great as at the eastern end (Pacific Ocean). Their salty course took them to many places including the Fiji Islands, New Zealand, New Guinea, Hong Kong, and Japan, with good opportunities to meet old friends in Manila and Taipei where they had spent about ten working years as Joel used his Course XI expertise in public health.

Travelers also indeed, are Mildred and **Art Shuey** of Shreveport. In August, Art favored us with a little itemizing: "This has been a year of travel for us—two-week cruise to the Antilles and spent evening with Sylvia and **Vertrees Young** at Pontchartrain in New Orleans. Home two weeks then to New York to sail on Olympia's *Eclipse 72* to see totality in mid-Atlantic. Flew to Scotland for a visit with relatives and a little trout fishing. Two weeks there, two weeks in London and now (August) leaving for two weeks in Colorado for some better fishing." . . . In late August **Kem Dean** wrote that he and Ada were about to take off for Boulder and other Colorado spots looking for somewhat lower temperatures and lower humidity than Houston. However, Kem is quick to add that air conditioning has made Houston "comfortable even in the hottest time of the year."

We are very sorry to report that **Lee Jones** of Elma, N.Y., died quite suddenly on August 2. Allie (Mrs. Ted C.) Jewett of Buffalo wrote that Lee's wife, Catherine, found him unconscious in the garden and he died the next morning. Lee's professional years were spent in railroading, manufacturing and real estate management. In a response to a question for the Class history, he indicated that contract administration in manufacturing gave him the most satisfaction. Asked what he did in retirement, he replied "Rake leaves, cut grass and serve as a travel agency representative." Both he and Catherine were at the 50th reunion at the Oyster Harbors Club in Osterville.

We regret to report the death in April of **Blythe Stason,** an electrical engineer who became the Dean of the University of Michigan Law School. He first taught electrical engineering in the University of Pennsylvania and in the University of Michigan. In 1922 he received his J.D. at the University of Michigan Law School and practiced law for two years in Sioux City. Then the University of Michigan made him a professor of law and in succession he became Provost of the University for six years and Dean of the Law School for 21 years until he retired in 1960. He continued teaching law at Vanderbilt University and worked in the American Bar Association and became known as an authority in International law on atomic energy.

We also regret to report the death in September of **Bill Drummey,** a renowned Boston architect and engineer. The *Boston Herald Traveler* reports that he was responsible for many major projects throughout the state, including the Boston University Bridge, Pondville Hospital, the M.D.T.A. yards in Everett, numerous industrial buildings and some 800 units of veterans housing. In the 1930's, he was "superintendent of school buildings in Boston and played a key role in the construction, design and financing of many schools built in that period. . . . He was the oldest living past president of the Boston Kiwanis Club, which in 1970 awarded him a gold medal for distinguished service among underprivileged children." In 1949-52 he was military aide to Governor Dever. A busy man, he attended reunions and made his own Christmas cards.

Once again we say, keep in touch! Write just a little but write often to help us keep the column full and presumably interesting.—**Harold F. Dodge,** Secretary, 96 Briarcliff Rd., Mountain Lakes, N.J. 07046; **Leonard Stone,** Assistant Secretary, 34-16 85th St., Jackson Heights, N.Y. 11372

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Thirty-five years is a long time to serve on any job, particularly a volunteer one. An appreciative letter from President Wiesner to **Ray Brooks** cites his 35 years of conscientious service as an Honorary Secretary and the successor Educational Council. Director Bill Hecht of the Council also thanks Ray for his long and valuable service. Ray was appointed in 1937 by Dr. Compton. One special interview he had was with Buzz Aldrin. Ray comments, "Surely I strongly recommended Buzz's acceptance by the Institute but West Point appointment was one that just couldn't be passed up. Anyway Buzz did come back to M.I.T." Several of our classmates have quietly interviewed, advised and helped many prospective M.I.T. students over the years and often at considerable time and inconvenience but to the benefit of the Institute. Ray feels that he wants to be free from obligating assignments to be able to "put some of what is left on personal affairs, friends and, if possible, some boat travel —all without a schedule I hope." The latest word on Ray is, "All A-OK even though I'm still a bit restricted physically. I'm taking off September 30 for a trip to France as one of a group of World War I Overseas Flyers."

The successful Alumni Officers Conference is reported in detail elsewhere in this issue and is recommended reading. We were represented by Sue and **Al Lunn,** Ruth and **Bill Dennen, Ray Stevens, Stan Lane, Penn Brooks** and **Stan Dunning.** At the 20th Anniversary Banquet of the Sloan School October Convocation, Penn Brooks is scheduled, as he was Dean from 1951 to 1959, for a tribute from President Wiesner. . . . **Will Neuberg** and **Dick Loengard** were the only '17ers at the '16-'17 luncheon on October 5; this time at the Chemists Club.

Walt Whitman comments, "Our 50th wedding anniversary last year brought all our grandchildren out to Arizona for a grand family reunion. Life is most pleasant and relaxed after ten years of retirement, although I've had to abandon the golf course. Martha Ann can still play. She's a stimulating companion." . . . There is this from **Leon Keach,** "As I work along in architecture the appearance of a reactionary client is a bonanza,

for otherwise the pleasure of design, in the old-fashioned roguish manner, would be denied me, so completely has the profession been metamorphosed over the last fifty-five years. Luckily New England still produces a sprinkling of sturdy reactionaries who enjoy being behind the times." . . . A vignette: along about 1911 **Stan Lane** and **John Holton** living a half-mile apart in Dorchester, Mass., built radios. Stan's was fancy with a roof antenna that aroused the curiosity of the neighborhood. John stepped his up with a magneto from a Model T. Both became efficient in the Morse Code and on occasion could bring in the only three commercial stations on the east coast and could signal each other faintly.

Regretfully the deaths are recorded of **John Harper** in New York City on July 17. . . . **Winfred Smith** on July 22 at Coopersburg, Penn., and **Lawrence Davis** on September 13 at Longmeadow, Mass.—**Stanley C. Dunning,** Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard,** Assistant Secretary, 21 East 87th St., New York, N.Y. 10018

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As I write these notes, active preparations are being made for our third Mini-reunion which will take place next Sunday, October 22, at Endicott House. This meeting is an innovation, a joint venture of the three Classes, 1917, 1918 and 1919. Hopefully, this experiment will result in future cooperative efforts. As of the moment, we expect about thirty '18ers, including wives, and about ten each, similarly, from '17 and '19. Our speaker will be Chancellor Paul Gray who, in turn, will present Professor Margaret MacVicar. She is responsible for some exciting innovations in teaching freshmen at M.I.T. More about this program in next month's report.

I am particularly impressed with the response to the invitations sent to you regarding the Mini-reunion. In addition to the number who accepted, over 50 who were too far away or had conflicts, responded with regrets at their inability to be with us here. Considering that our active mailing list is about 175, I consider your courtesy a good indication of a strong, resurgent Class spirit.

Through the kindness of Louise Tucker, I enclose excerpts from an article in *Tech Talk,* August 9, 1972, with reference to Carlton's contribution to the M.I.T. telephone system called Centrex. "A recent history of the telephone at the Institute cannot be complete without discussing the contributions of Professor **Carlton Tucker** of the Electrical Engineering Department. He was recognized as an authority on telephone communications and made a substantial contribution to the Institute's phone service. One of the final contributions Professor Tucker made to Institute telephone service before his death in 1966 was the design of the Institute information switchboard. Using his design the information operator could connect a caller directly with his desired extension." Professor Tucker was responsible for the block number system developed in the late 1930s and was instrumental in creating the dormitory telephone system of which some of the original equipment is still in use today.

On October 5, 6 and 7, the 1972 M.I.T. Alumni Officers Conference took place at the Institute. The Class of 1918 was represented by **John Kilduff, Julian Howe, Harry LeVine,** and your Secretary. Incidentally, I served on the Planning Committee, which helped make these meetings most successful—all of which is reported in other columns of the *Review.*

Charlie Tavener married the former Mrs. Leach last August and will now divide his time between Florida and New Jersey with many side trips to grandchildren in the New England area. Congratulations and good health and happiness to both of you! . . .The **George Sacketts** are moving this week from Connecticut to Taunton, Mass., which will bring them closer to their daughter—and to us. He is making his reservation now for our 55th. . . . We are blessed with two **Samuel Chamberlains. Samuel V.** and his wife will be with us at Endicott House. Unfortunately, **Samuel H.** has some illness at home which restricts his movement. He sent his regrets, but he invited me and you to drop in at 54 Warren Ave., Plymouth, at any time. . . . The **Julie Howes** opened their Bill Will's house to the League of Women Voters with its authentic early American antiques.

For no reason I can explain, there is a dearth of personal news. I want you to stop sitting on your hands and take a pen in hand. Send in items of personal interest to me post haste. All of us want to know about you.—**Max Seltzer,** Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard Levine,** Assistant Secretary, 519 Washington St., Apt. 15, Brookline, Mass. 02146

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Audrey P. Ames writes from 1980 Washington St., San Francisco, Calif. "After two years pretty much out of circulation due to eye trouble and cataract operations, I am now reading, driving the car and golfing again." . . . **Morton A. Smith** writes to say he is still at Great Barrington, Mass. "Sold my radio business nine years ago but as my wife is an invalid I have to run the house and take care of her. I still do some radio servicing. It is just 50 years this spring since I started that, which should be a record for continuous operation."

The following deaths were reported by the Alumni Association: **George A. Inglis,** Clearwater, Fla., on March 12, 1965; **Fred P. Baker,** Denver, Colo., on May 29, 1972; **Paul G. Jenney,** Egypt, Miss., on January 25, 1972; **Walter R. McKenney,** Lakewood, Ohio on May 31, 1972; **Ralph H. Pease,** Torrington, Conn., on August 16, 1971.

George Michelson wrote Aug. 21st mailing a clipping from the Brookline, Mass. *Chronicle Citizen,* telling of the passing of **Max Untersee,** Aug. 3, 1972. Max Untersee was a consulting architect for the Directorate of Civil Engineering, Space and Missile Systems organization. George is now chairman of the board of J. Slotnik Co., and they have just completed a most unusual building for the Harvard School of Design. George's son is president of his company. George has 10 grandchildren.

Fred P. Baker's death was reported in *The Denver Post,* June 2, 1972. He was the founder of Baker Auto Rental and Baker Truck Rental. Baker became an officer of Ryder System Inc. after Baker's companies merged with Ryder. He retired as Ryder's president in 1962.—**E. R. Smoley,** Secretary, 50 East Rd., Apt. 11E, Delray Beach, Fla., 33444

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Our Class has lost one of its most illustrious and most beloved members. **Bob Patterson** died early in October after a long illness. Funeral services were held at the Technology Chapel and a number of our classmates were present including **Norrie Abbott** and Betty, **Ed Ryer, Al Burke, Jesse Doyle,** and your Secretary. Bob served for many years as an executive officer of the John Hancock Mutual Life Insurance Co. He was vice president in charge of finance until his retirement in 1961. He then became treasurer and director of Four Square Fund, Inc., and Four Squares Inc. A native of Glasgow, Scotland, he came to the United States in 1914 and rose steadily to prominence in the business and financial world. After graduation, he became associated with E. J. Phillips and Co., and was manager of the Albany office of Rogers Caldwell and Co. He then served as vice president and treasurer of Prescott Grover and Son in New York City before returning to Boston. He was a director of Curtis Publishing Co., Joy Fund Inc., honorary director of High Voltage Engineering Corp., a trustee of the Park Street Church, and corporator of the Sinking Fund of Boston. An artist of considerable repute, Bob was widely known and admired for his paintings. He leaves his wife, Laura, who lives at 54 Fayette St., Boston. In his memory, contributions to the Robert D. Patterson M.I.T. Memorial Fund may be made at 77 Mass. Ave., Cambridge.

El Wason thoughtfully sends me a news clipping showing a good picture of **Al Fraser** and featuring his appointment as Honorary Grand Marshal for Wellesley's annual Veterans Day parade. Al merited this honor as a longtime and most popular resident of Wellesley where he went to high school before joining our class at M.I.T. After graduation he became associated with his father who was a leading florist of the town and has developed the business into what is undoubtedly the best known and liked in the area of flowers and floral decorations. He has been constantly active in town affairs, was one of the original Town Meeting members and a member of the Advisory Committee and Planning Board. El Wason says he runs into Al frequently as El is a resident of Wellesley Hills. El is an active member of the retired men's clubs of both Newton and Needham and reports seeing **Al Burke** and **Phil Wait** frequently, and of course, his twin brother Al.

A cheerful letter from **Jim Gibson** tells of his grand celebration at Brooksville,

Maine, on the occasion of his 75th birthday, and also refers to the fact that he helped **Buck Clark** to celebrate *his* 75th earlier this year. Jim says that as soon as the frost is on the pumpkin, he and Lucy, like smart robins, will be taking off for the south. Last winter they stayed at their usual haunt in Sarasota but interspersed this with a trip to Italy and Spain. Jim comments on Amy's and my recent visit to Scotland and Sterling Castle, the homestead of the Gibson's which we visited. We also had a delightful visit at the Edinburgh home of one Geroge Gibson (any relation Jim?) Accompanied by our neighbor, a native of Scotland who did all the left-hand driving, we roamed all over the Western Highlands (1100 miles), had exceedingly fine weather the entire trip and I even experienced the thrill of playing 18 holes on the famous Kings Course at Gleneagles. . . . Thanks, **Art Merriman,** for your friendly birthday greeting. (How did you know?) Art says he hopes to see us at the reunion in 1975. We do look forward to that!

Recent address changes include: Howard Brooks, Ferro Enameling Co., 1100 57th Ave., Oakland, Calif.; Oswald Cooper, 2710 Broadway, San Francisco; David Reed, Box 162, Brevard, N.C.; and Dan Whelan, 15318 DePauw St., Pacific Palisades, Calif.

Word has been received of the death of **Raymond S. Coward** of Red Bluff, Calif. No details.

Have a good winter, fellows. Keep active, and in good health and enjoying life.—**Harold Bugbee,** Secretary, 21 Everell Road, Winchester, Mass. 01890

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The Alumni Officers Conference has just concluded as these notes are being written and all hands report a very stimulating session. Quoting one class officer: "It is truly fantastic how much the Institute is involved in projects of all kinds." Attending from our class were Winn and **Royal Wood,** Emma and **Al Lloyd, Ted Steffian, Ed Dubé, Joe Wenick** and **Irving Jakobson.** Incidentally, Ed Dubé was briefly hospitalized early in September because of a low blood pressure situation. He has resumed normal activities and expresses his gratitude to the many friends that rallied around.

The detailed program for the 25th Fiesta of the M.I.T. Club of Mexico was received from **Cac Clarke** who was elected Executive Secretary, U.S.A., by the Club. Cac urges getting reservations in promptly because with a limit of 100 U.S.A. guests, late starters may be disappointed. If you haven't done so, send in your application immediately to the Club in Mexico City, or phone Cac in Brielle, N.J. Also let **Al Lloyd** know as he is coordinating arrangements for this 1921 Interim Reunion. Particularly interesting in addition to a wonderful three-day program are plans for tours to other colorful parts of Mexico.

Last May, Ruth and **Irving Jakobson** drove over the George Washington bridge one day and joined forces with the Haywards for lunch. Jake told about his trip from Florida to Maryland on the inland waterway with Don Carpenter, '22. One night Jake was chef in the Great Dismal Swamp and dreamt of beef burgundy. The nearest approach to it he could concoct was canned meatball stew over which one full bottle of Madiera was poured. "Delicious" reported Don Carpenter on Alumni Day. In early August, Jake sailed his boat to Mystic, Block Island and Martha's Vineyard. . . . Emma and **Al Lloyd** drove over to Mystic and took Jake to their home in Westerly, R.I., for dinner and an evening gab fest. Late in August, the Jakobsons were hosts at dinner to the **Ray Coopers,** the **Dayton Browns** and the **Haywards.** The next day your Secretary enjoyed a wonderful day of sailing on Long Island Sound in Jake's boat. The sun came up over the yardarm at 11:59 and one half.

The back panels of Alumni Fund envelopes were the source of news from six of our classmates. (*Please*—more of you do this! A minute's jottings can supply a brief summary of what you're doing and planning, and how you're feeling.) **Phil Nelles, Jr.,** wrote that "we have finally shaken the sands of Cape Cod from our shoes and use our Stoneham, Mass., address as home base." Does this apply to next summer, Phil? . . . Dr. **Elmer W. Campbell,** who summers in Lovell, Maine now lists 9068 Briarwood Dr., Seminole, Fla., 33542 as his home address. He and Becky were planning a bus tour to Colorado Springs with 26 others in September to attend the national convention of the RETREADS—an organization of veterans that served in both World Wars. Elmer was elected Commander of the Tampa Bay Area Hut #2 and also Medical Officer of the Department of Florida RETREADS. . . . **Joseph G. Kaufman,** 16300 W 9-Mile Rd., #915, Southfield, Mich., 48075, wrote that he had been in and out of the hospital and is now using an electric pace maker. Drop him a line. Hope you're feeling stronger, Joe.

Harry M. Ramsay, 1974 David Dr., Escondido, Calif., 92025 recently had successful cataract surgery and wrote how great it was to have the other eye a perfect one. Said Harry, "How fortunate can one be? All else, A-OK!" Cheers! . . . **Wolfe W. Brown** spent the summer fishing on Portage Lake, Mich. What luck? Bill took a Caribbean cruise last January and then spent three months at his son's home in N. J. Bill now resides in Cleveland, Ohio. . . . **Richmond S. Clark** of La Porte, Texas wrote that he was not trying to start a contest when a letter to Cac Clarke a year ago stated that he probably had known Ray St. Laurent longer than anyone else in the Class. Rich, don't you know that Class Secretaries love to start contests? This is one way of gathering news.

A phone call to **Albert E. Fowler, Jr.,** of Somerville, N.J., disclosed that the Fowlers were moving to 6974 So. Garfield Way, Littleton, Colo., 80122 in late October. Helen and Al spent the summer at their cottage on Plum Island, Newburyport. "Lobsters were scarce and expensive this summer," said Al, "and I've found out why. Helen and our son, Richard, '49, went out to Colorado to look for a house and there on the menu in a restaurant was Broiled Maine Lobster. That's why lobsters are scarce in Massachusetts." . . . Those of you that read the article in the July/August *Technology Review* on "American Indian Communities" will have noted that John Ames Steffian, Associate Professor of Architecture at M.I.T. was co-director of the pueblo-study project. John is the son of our Vice President, **Ted Steffian.**

A postcard received from **Ralph Shaw** of Beverly, N.J., in August sent greetings from Honolulu, "where the hula is history and all the gals do rock and roll." Madeline and Rufe also visited Colorado Springs and Yosemite Park on the way. . . . A nice letter from **Helier Rodriguez** of Tampa, Fla., told of a dinner invitation from **Oliver Bardes** at the Bardmoor Country Club in Largo, Fla. Ollie has offered to give a party at the clubhouse if the Class goes ahead with an interim reunion in Florida in 1973 or 1974. Helier described Bardmoor as "very attractive, on top of a little hill and having a fine restaurant." . . . The Rodriguezes left on a six-week trip to Spain and Italy in September and a postcard mailed from Madrid reported a very enjoyable visit with old friends and the delight of seeing familiar places.

George Chutter of East Dennis, Mass., wrote that he played golf with **Bob Miller,** our Class photographer, late in August. Leila and Assistant Secretary, **Sam Lunden** were also on Cape Cod and were hosts one evening to a supper at their cottage in South Dennis. At the supper were Mildred and **Don McGuire,** Hazel and **Whitney Wetherell,** Marion and **George Chutter,** and Helen and **Bob Miller.** The Chutters left for Grand Rapids, Mich. in October for a visit with their son, Roger, and his family. Your Secretary is informed that Sam Lunden did use his authority conferred by his Honorary-Admiral certificate to steer his motor boat and fish around Cape Cod this past summer. Catch any blowfish?

A postcard mailed from Pugwash, Nova Scotia by Helen St. Laurent pictured surf breaking over a rocky coast. Helen was visiting her sister-in-law after spending the summer at Saint's Haven on Vinalhaven. . . . **Richard W. Smith** of Chevy Chase, Md., sent a clipping from the *Boston Sunday Globe* describing the financial plight of a dairy farm in West Bridgewater, Mass., owned by descendents of the original owner, Thomas Hayward (Dick Smith and your Secretary's common ancestor.) The farm has come down through ten generations since 1649. Dick continues to pursue his genealogical research and correspondence, hunting down his and his wife Kitty's forebears.

With sadness we report the death of one of our classmates, **Walter A. Jayme** of Woodcliff Lake, N.J. The sympathy of the Class is extended to his family.

New addresses: Dana A. Barnes, c/o Porter, 4626 Thompson #1, Anchorage, Alaska 99504; Dr. John Campbell, P.O. Box 219, Port Rowan, Ont., Canada CA 690; Dr. Joseph Fowler, Wed Enterprises, 1401 Flower St., Glendale, Calif. 91201; Herbert A. Kaufmann, 9 Sandy Cove Rd., Sarasota, Fla. 33581; W. Hoyt Young, Jr., 1887 E. Sheridan Ave., Escondido, Calif. 92025.

Mrs. Durwin David Algyer and Mr. **James Stewart Parsons** announce their marriage on September 30, 1972. They will be at home after May 15, 1973 at East Shore Rd. Piseco, N.Y. 12139. Congratulations, Jim!

Your Secretaries wish you all the joys of the Holiday Season.—**Sumner Hayward,** Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby,** Assistant Secretary for Florida, 3310 Sheffield Cir., Sarasota, Fla., 33580; **Samuel E. Lunden,** Assistant Secretary for California, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

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As we often say here in Buffalo, summer ends on November 15 and shortly thereafter we can store our golf clubs and drain the water systems in the summer homes along Lake Erie. In the meantime your Secretary has moved from a large house to a small apartment, regretfully being denied the exercise of raking leaves, cleaning gutters and painting here and there. This leaves time to review the program and notes of our 50th Reunion and appreciate the experiences of those enjoyable days.

Wasn't it fun to check in on Thursday, June 1 at M.I.T. to receive room assignments in McCormick Hall and meet some wonderful people during the social hour and buffet dinner? Remember the class picture on Friday morning with red coats and berets, the robing and procession to seats of honor on the stage at Commencement? Think of the pleasure of watching class movies in the afternoon and visiting with the M.I.T. official family at the reception in McCormick Court that evening! Saturday started with another big breakfast and continued enjoyably on the busses to the Hotel Wentworth at Newcastle, N.H., for the New England clambake and shore dinner under sunny skies. The day ended with the courtyard reception before the buffet supper and the official class meeting. Then came the church services on Sunday followed by the christening of an eight-oar racing shell, "Catherine McCurdy," at the boat house, the reception at President Wiesner's, the international buffet and the Sunday evening at the Pops with Arthur Fiedler. Monday's Alumni Day included lectures, the Memorial Service, the Alumni Day luncheon and more lectures. And finally came the Alumni cocktail party in du Pont and supper at the Student Center. It was truly a remarkable experience enjoyed by everyone present.

We received a letter from **Horace McCurdy** enclosing a copy of the scroll and plaque of appreciation for **Parke Appel** with the original signatures of those present on Alumni Day. It conveys our thanks to Madeline and Parke for years of effort in our behalf. The scroll reads "This memento of the Fiftieth Reunion of the Class of 1922 is presented to Parke D. Appel, President of the Class, by us, his friends and fellow alumni, in grateful appreciation of his energy, dedication, and unceasing labors which made the Golden Anniversary Reunion a memorable experience for us all." It's good to know that all the Class, including those unable to be with us, share in this tribute. . . . We have another note about Kate and Mac McCurdy. They spent the summer cruising aboard *Blue Peter* and relaxing at their summer home, Bute Island. They actually spent 71 days aboard ship. Mac has just published a limited edition of *The Collected Works of James G. McCurdy* complete with photographs of sailing vessels seen along the Pacific Northwest Coast during the 1800s. We are most grateful for copy #31. . . . Carole A. Clarke, perennial Secretary of M.I.T.'s Class of '21, forwarded the Fiesta in Mexico program for 1973. The Fiesta will celebrate it's 25th Mexican anniversary on March 15, 16, 17 with President Wiesner and possibly the Killians, Johnsons, and Strattons. The Class of '22 was not represented last year and it is hoped that an interim class reunion in Mexico next March would be popular. Maxine and Cac have been attending the University of Guanajuato.

Did you know that our Class set a record for a 50th year gift with $909,000 donated by 337 classmates? An additional $685,000 has been pledged to M.I.T. in bequests by 28 members of the Class. We have also set up a Career Development Fund which now totals about $330,000 to support promising young faculty members. A discouraging note received from the Alumni Association however, listed 87 names of 1922 inactive alumni from Alfred C. Anderson to Adolfo Zambrano. We are sorry to miss their correspondence and companionship.

Roger Hayward is still illustrating the Amateur Scientist column for the *Scientific American* as he has since 1949. He asks "whatever happened to Miss Mall-Muggins?" . . . The first **Eric Hodgins** Memorial Scholarship has been awarded to Jeffrey M. Baerman of Skokie, Ill. The Hodgins Scholarship Fund was established in 1971 by *Time, Inc.* as a tribute to Eric. . . . We received a message from Katherine and **Dale Spoor** mailed in Leningrad telling of their North Cape trip on the Sagafjord. They cruised down the fjords of Norway, then to Denmark, Sweden, Leningrad, Moscow, Helsinki, Stockholm, Hamburg, Amsterdam and finally back to New York in August. They are now planning their next trip to the romantic South Pacific. . . . We were amazed to receive a notice from M.I.T. that **Whitworth Ferguson** was awarded the 1972 Chancellor's Medal, the highest honor bestowed by the State University of New York at Buffalo, at its 126th annual commencement ceremonies in May. The medal is too large to wear comfortably so you are invited to come to Buffalo to see it. . . . A card from the Anglais Hotel in Stockholm signed by Fran and **Al Sargent** tells about their Scandinavian safari. This included a week in Norway and the fjord country and on to Copenhagen, a most enjoyable trip.

Fearing Pratt sent word of the loss of **Eben Hayward Baker** of Course II. He was busily engaged in his company, The Teepee Archery Tackle Co. of Auburndale, Mass. His interests included sportsmen's groups and a Boy Scout troop. He is survived by his wife Ruth, a son and two daughters. . . . The sympathy of the Class is also extended to the family of **Henry Langdon Haltermann** of Middletown, R.I. He was a retired civil engineer and worked primarily in the New York city area. He was a major in the U.S. Army Air Corps during World War II, and a former chairman of deacons of the United Congregational Church in Newport. We also extend our sympathy to Mrs. **Paul Ryan** of Larchmont, N.Y.

Among the changes of address received are: Richard Allen, San Francisco, Cal.; Edward A. Ash, Homestead, Fla.; John F. Austin, Jr., Dallas, Tx.; Commander Kenneth Bernard, Arlington, Va.; Sidney M. Biddell, Los Angeles, Cal.; George T. Boli, Sarasota, Fla.; Professor Edward L. Bowles, Wellesley Hills, Mass.; Harold S. Bronson, Rochester, N.Y.; Edwin C. Brown, Pompano Beach, Fla.; I. Robert Loss, Phillipsburg, N.J. All this and a Healthful Merry Christmas to you!—**Whitworth Ferguson,** Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar H. Horovitz,** Assistant Secretary, 3001 South Ccurse Dr., Apt. 103, Pompano Beach, Fla. 33060

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The news from classmates is so skimpy as to make the writing of this column almost needless. There are a few interesting items, so here goes it. We learn that Dean **John E. Burchard** (emeritus) of our School of Humanities has been named director of the San Francisco area Bay Area Rapid Transit (BART) Art Council formed to guide a program of placing art in 20 BART stations. . . . **Emil S. Birkenwald** writes "Have retired from employ of Southern Railway Company since December 1, 1967. However, I am engaged in consulting on railway bridges for two railroads with offices in Atlanta."

The second meeting of the 50th Reunion Committee was hosted by Chairman **Herb Hayden** on October 11, 1972 at his home in Lancaster, Mass. The following were present: David W. Skinner; Charles Burke; Horatio Bond; Forrest Lange; Royal Sterling; and James A. (Pete) Pennypacker. Pete made the meeting report and tells us that the program is now practically finalized, our class gift will be most sizable and that so far 157 classmates have contributed class dues for the years 1971 and 1972. (We are not assessing dues for prior years.) Other matters were discussed at great length including the controversial class jacket proposal which, it appears, will be resolved in a much less expensive manner than formerly proposed. All in all, the 50th Reunion (May 30-June 3, 1973) promises to be a great affair, so reserve these dates now and plan to attend. We will stay, that is most of us, at the Marriott Motor Hotel near Route 128 in the Newtons and there will be bus service to M.I.T. as needed to attend all functions. You will have learned more about this by the time this column is published.

Sadly we learn of two more deaths, **Richard W. Lambrecht** of Grosse Point Farms, Mich., on May 13, 1972, and **Herbert E. Wilks** of South Hamilton, Mass.,

on August 19, 1972. We have no further details. About ten more addresses have changed but in line with the need to conserve space we will not repeat these. Anyone having a "mail return, address unknown" please advise and I will provide the latest.—**Thomas E. Rounds,** Secretary-Treasurer, 4 Deer Hill Dr., Danbury, Ct., 06810

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One of the advantages of living in Boston, land of the bean and the cod, where the Cabots speak only to the Lodges and the Lodges formerly spoke only to God, is the availability of the Institute with its exciting and stimulating programs. The recent Alumni Officers Conference was attended by **Luis Ferre, Ed Moll, Dick Lassiter, Jack Cannon** and your scribe. The theme was basically Education but the discussion group on the Faculty and the panel on "New Teaching and Research Activities" led by Provost Dr. Walter Rosenblith were superb. The innovations by professors in the various disciplines were almost frightening to us old-timers, but success in the field is visible proof of solid thinking.

Our 50th Reunion Chairman, **Paul Cardinal,** tops the list for activity. In Naples, Fla., on August 22, after a two-month safari in New York and environs, he reports several accomplishments for the Class. Kay Atherton will head a committee to contact widows of classmates. Paul suggested procedures for **Jack Hennessy**'s office relating to our 50th Gift Fund. . . . Classmates have sent a gift to the Environmental Library Fund in memory of **Jack Tench.** Paul and Lorene visited **Gordon Harvey** and Clare in Fort Lauderdale and report good progress by Gordon.

Ken Brock has advised Betty Kane that the income from a Memorial Fund in **Chick Kane**'s name, now standing at $7,234 will be a gift to M.I.T. each year in perpetuity. Contributors were from former members of the Alumni Fund Board and officers of the Association.

Bill Correale, my man in New York, sends a clipping reporting the death of **Harold P. Kurzman** on September 30, 1972, of a heart attack at his home, 1020 Park Ave., N.Y.C. He was a Course XV graduate and entered the merchandising field, becoming president of Lily of France, Inc., manufacturers of foundation garments. After selling his business in 1963, he devoted himself to philanthropic activities. . . . From George Tapley in Haverhill, Mass., a clipping on the death of **Carroll L. Dunn** on September 15, 1972 in Laconia, N.H. Dunnie was a mechanical engineer and best known as a member of the swimming team for four years. He had a varied career, including part ownership of a Pontiac agency in Haverhill which he sold and joined the Pope Machinery Corp., Haverhill. He was active in civic organizations and held numerous high offices in the Masonic order. The Class extends its sincere sympathies to the wives and families of our departed members.

Professor **Thomas K. Sherwood,** now at the University of California, Berkeley, one of our most distinguished academic members, is the winner for 1973 of the $2,000 E. V. Murphree Award in Industrial and Engineering Chemistry. The award is sponsored by the Esso Research and Engineering Co.

A consultant in chemical engineering for many years, Dr. Sherwood is being recognized primarily for his pioneering work in the understanding and development of mass transfer. He gained his S.M. in 1924 at the Institute, and Sc.D. in 1929, joining the faculty for full time in 1930. Advancing through professorships, Dr. Sherwood was Dean of Engineering from 1946 to 1952. He retired from M.I.T. in 1969 and moved to Berkeley. He is a member of many societies and honorary fraternities, as well as an author of comprehensive texts. From 1940 to 1946, he was an expert consultant, civilian status, to the War and Defense Departments.

The editors of *Tech Talk,* a weekly M.I.T. publication, are so enthusiastic about the prospects of the new Council for the Arts at M.I.T., that they visited **Paul Tishman** in his New York apartment in September. He is a noted collector of African art and a moving spirit behind the Council. Only part of his collection is displayed in one room, but Paul stressed the fact that the objects alone would be trivial from the African point of view. Western art is thought of as being produced by a small group called artists, but African art was produced by workers continuously for thousands of years.

As these notes were going to press, word was received that Paul, as Chairman of the newly formed Council for the Arts at M.I.T., announced gifts of $100,000 to support its initial operations. Speaking to an audience of 100 attending the first Council meeting, he hailed the gifts as evidence of a major commitment to a new pace for American education. I hope that Jack Hennessy can make a similar announcement for our 50th Environmental Laboratory Gift.

On September 18, **Si Duevel** and Mary took off for Madrid and a month in the rest of Europe, just before your scribe ran across an article, "Nudism Flourishing Along the Adriatic." Maybe this was an inspiration to attend the forthcoming Nudist International Convention, but the article warned that nudist security police will exercise more stringent controls than those at any national border crossing. A valid membership card from a local nudist club must be produced. Wonder if it has to have a photograph attached?

Maynard L. (Lank) Harris advises that he daily joggles his anatomy by riding horseback on his estate and environs. I wondered how he mounted, but then recalled that in his recent "For the Fun of It," piece he described his difficulty in purchasing an extension ladder. Lank, will avoid the snow and cold this winter in the warm, dry air of Arizona.—**Russell W. Ambach,** Secretary, 135 Aspinwall Ave., Brookline, Mass. 02146

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Masuru Kametani finally paid his promised visit to M.I.T. in late August. Kammy arrived when most of the persons that he wished to see were out of town but I did contact them by phone and they sent regards. . . . **Arthur Odegard** acted as host for part of the visit and I met them at the Student Center where I had the pleasure of receiving Kammy's annual contribution to the Alumni Fund. This must be a long distance record for payment in person. . . . A note from **Jim Clifford** with thanks for the article in the *Review* and complimenting them for the clearness of the reproduction of the photograph. . . . **James C. Evans** was elected to the Board of Directors of the Industrial Bank of Washington, D.C.

Charles Myers Billman of Dayton, Ohio, recently completed an overseas assignment for the International Executive Service Corps. He was in Indonesia to advise a cement manufacturer on financial management. **Nicholas A. Draim** of Ventura, Calif., is retired but active. He recently presented a paper on "A General Algorithm for Factorization" at a math conference in San Francisco. He enclosed a copy of the paper for the M.I.T. Math Department. **Francis J. Mulcahy** retired from the General Service Administration in Boston early in 1971. He is occupied in enjoying the progress of a new grandchild who fortunately lives nearby. On October 6 and 7, I attended a Class Officers Conference at M.I.T. In addition to myself, the following members of our Class were in attendance; Doc Foster, Chink Drew, Jim Howard and Karl VanTassel. We managed to get together for most of the meals and had an opportunity to exchange views. I am sure we all enjoyed the conference and left with the impression that M.I.T. was headed in the right direction both in the immediate and long-range future.

I am sorry to report the passing of several classmates. **Grant F. Mayell** of Paoli, Pa., passed away on August 13, 1972. He was buried in Akron, N.Y. A note from his wife tells of his interest in reading of M.I.T.'s progress and the activities of his Class. . . . A note from Garvin Drew calls attention to the death of **Ralph O. Ballentine** of Rochester, N.H., last summer. . . . A clipping from a local paper records the death of **Guy C. Canfield** of Brockton, Mass., on July 30, 1972. He was a native of Attleboro, Mass., but had been a resident of Brockton for 22 years prior to his death. He is survived by his widow, a son and seven grandchildren. . . . **Allen L. Briggs** of Jamestown, N.Y. passed away on June 7, 1970.

This is the time of the year when I may take the opportunity to extend to all of you the best of wishes for the season.—**E. Willard Gardiner** (Will), Secretary, 53 Foster St., Cambridge, Mass. 02138

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We recently ran across an interesting story about classmate **Bob Dean** in a publication called *Vision.* Bob's firm was the architect for the new library at Bentley College and Bob was instrumental in using a decorative plaster design—something we think of as belonging to a few generations back but, of course, less ornate. Described in *Vision*: "In the cen-

Paul Tishman on African Art and Our African Heritage

The following recollection of a visit to Paul Tishman, '24, by Peter D. Spackman, Assistant Director of the M.I.T. News Office, has been adapted from Mr. Spackman's account in Tech Talk, *the M.I.T. weekly newspaper:*

An hour of conversation that changes one's view of the world—that is a gift of no little magnitude. The man to whom we are in debt is Paul Tishman, a noted collector of African art, a passionate man and a pursuer of causes worth pursuing. Mr. Tishman has served on the M.I.T. Committee for the Visual Arts, lent selections of his collection for exhibit at Hayden Gallery three years ago, and is a moving spirit behind a new Council for the Arts at M.I.T.

Paying him a visit in his Sutton Place apartment in New York, we were quite unprepared for the effect of a first confrontation with what turned out to be only a part of the Tishman collection. Mr. Tishman's study, which overlooks the East River, commands a spectacular view, but it is a tribute to the power of the art he has assembled that a visitor overlooks the outside because of what the room contains. The study is about 25 ft. square, and its four walls are lined with masks and sculptures—over 100 of the most compelling objects we have ever seen. An almost palpable force, a gathered energy of an intensity that could only be called holy, emanates from these assembled works. From the point-blank holes in masks, from visages of rough or polished wood, from heads and totems, from faces of terra-cotta and bronze the hundred eyes of a complex culture burn out at the visitor.

We suggested that he must be a strong man to work in the presence of such power. "They are strong works, aren't they?" Mr. Tishman agreed. The first thing you have to do if you want to begin to understand the art of Black Africa," he told us, "is to forget the word 'art'."

"Western art is for display—as this is here, but you have to realize that this is taken totally out of context. Art for display alone would simply be trivial from the African point of view." As Mr. Tishman continued to explain the differences between an art oriented to ornamentation and an art for daily use, we began to realize that the West had come to think of art as something produced by a small group of people called artists, something in a special category of its own, divorced from life. But the real involvement so lacking here has existed in Africa for literally, millenia.

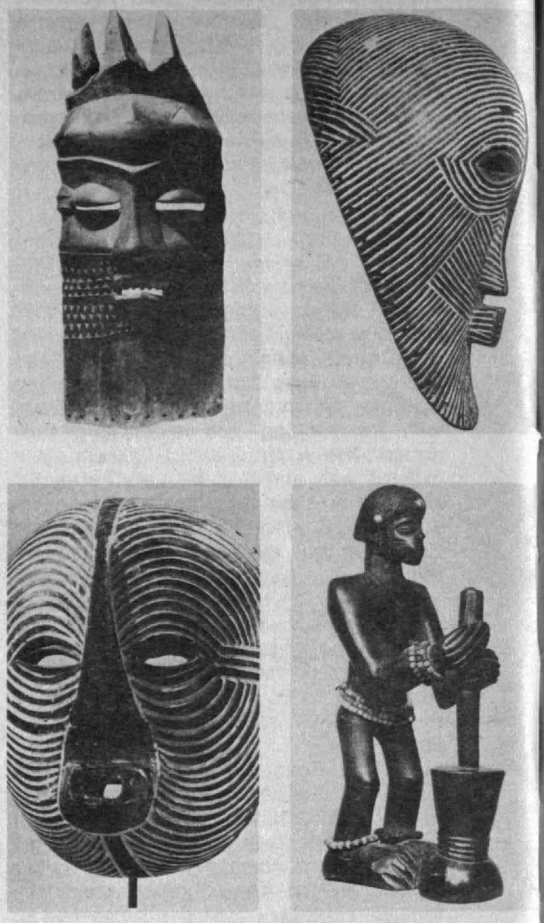
"You know the stereotype of deepest, darkest Africa is quite false," Mr. Tishman told us firmly. "The best research we have indicates that a very complex, rich, articulated culture has existed in an unbroken line in Africa for thousands of years—a very long time indeed. It is difficult to reconstruct historically because there are no written materials from early African history, a condition that led early anthropologists to assume, mistakenly that African culture was 'primitive' and 'pre-literate.' But the fact is that African philosophy, profound and complex, was articulated through manifold cultural events. These art objects are literature in a very real sense.

"The Africans saw," Mr. Tishman went on warming to his subject, "that much of human life—indeed the most important aspect of life—was deeply mysterious, and they embodied these mysteries in various spiritual forces and allowed them to permeate their whole existence. The African tradition is not only oral; it is ceremonial, emotional and physical as in dance, musical, and artistic all at once because it was through the combined power of all these elements that Africans expressed their views of reality. The Greeks, for example, made extraordinarily beautiful sculptures to express their views, and in essence what they did was to make gods of men. To the African, who was much more pragmatic, that would just be silly. Men could not be gods; they were men.

"Of course not all the meanings of their art were available to all. Some particularly holy objects were kept away in the houses of kings and priests, for example, or in special places in the jungle to mark a site or protect a village. Art was not made by special people, but by workers who made the other useful utensils of everyday life. And some of the things we now regard as objects of art were really badges of special office, kept by various civil servants, chiefs of police, justices of their supreme courts and the like. Did you know that African kingdoms sent people to England to learn English well before Shakespeare's time?"

Mr. Tishman has allowed his collection to be widely exhibited as a venture in the education of black and white alike. "There is such immense dignity and thought in the African heritage," he said, "that it seems to give black people a new sense of self-respect and white people a new sense of respect. Our cultural debt to Africa is simply enormous, and for the most part unknown or unacknowledged. Nearly all our music, for instance, stems from African rhythmic and melodic ideas. Modern dance is taken directly from the Africa heritage. Our language has been enriched: the phrase 'do one's thing', for example, is African.

"And of course it was African people who developed the concepts of abstraction in art that have proved so fruitful in Western art of all kinds." Mr. Tishman pointed to an imposing figure of a woman, sculpted in dark wood. "Even when an African artist did a portrait of a queen, it was not really of that person, of a single woman, but rather a picture of womanliness and what that meant. This abstract, generalizing impulse is present in most traditional African art. It was meant to be used. And the power of the object was infused with spiritual energy. You know, we still speak of 'inspired' artistic work, but we've really forgotten the spiritual force that art is about. The word has just become a habit. These works, humane and religious, don't let you forget that."



Some selections from Paul Tishman's collection of African sculpture. As Mr. Spackman remarks in his interview, only a strong man indeed could be involved in the study of such powerful pieces as these. Top, left, a Ba Pende initiation mask. Top, right, a Basonge mask, supposedly used in the kifwebe society about which little is known; it is thought that certain of these masks may represent the spirits of the dead. Center, left a Baluba society mask, from the Congo interior. Center, right, a light wood statuette, dyed dark brown, of a woman working at a mortar, a common theme in Chokwe-Lunda statuary. The term Chokwe refers to groups of people living across the southern fringe of the Congo. The Chokwe were traders in slaves and ivory.

ter of the Library is an open space, giving the desk on the main floor visual control also of the floor above. This tall space is covered by a plaster dome carried on plaster pendentives. In the center of the dome, plastic let's natural light into the center of the Library. Plaster was chosen for the dome since no other material could have been used to form the dome in place." We plan to drive by the library and take a look at Bob's work.

The chairman of the Class of '26 Gift has made an important gift of his own to the M.I.T. Libraries. A collection of 30 rare books estimated at a value exceeding $100,000 and containing a perfect page from the Gutenberg Bible, a book from George Washington's library, and a first edition of Thomas Paine's *Common Sense,* was given to the Libraries of M.I.T. by **I. Austin Kelly, 3rd.** The collection was given to M.I.T. as a tribute to William N. Locke, who is retiring this spring as Director of Libraries after 16 years. Mr. Kelly and Professor Locke are old friends. "I know of no better way to express my admiration for Professor Locke, and for M.I.T., than to have this important work as a permanent part of the Institute Library," Mr. Kelly said. Say Austin, how about presenting each class of '26 donor to the 50th Gift a reproduction of this booklet *Common Sense.*

Professor **Les Hamilton** thoughtfully wrote us the following note: "This clipping concerning **Phil Richardson** is from the local paper, the *Boothbay Register,* August 17, 1972. I saw Phil shortly before his death and was notified by the memorial service but could not attend. Phil worked for many of his summers at M.I.T. working with Bernie Proctor on a problem related to Professor Proctor's work in Food Chemistry. He knew everyone in Biology." The clipping tells of Phil's death on August 13. Phil had been chairman of the Department of Biology at Simmons College before his retirement in 1969.

We have a news release of another classmate. "**Duncan A. Crawford,** former President and Director of Atlanta Gas Light Company, died at Hyannis Port, Mass. Tuesday, May 9. Born August 4, 1904 at Dedham, Mass., Mr. Crawford was a 1926 graduate of M.I.T. with a B.S. degree in electrical engineering. Survivors include his wife, the former Grace Whitney of Dedham; a son, David, a vice president of Southern Cross Corp.; and a daughter, Barbara."

Finally, just a few days ago Ken Brock sent us a clipping that told of the unexpected death of Dorothy Cunningham, the wife of our permanent reunion chairman, **Don Cunningham.** Dot was at our last reunion and had successfully recovered from heart surgery. Don tells us that she just didn't wake up one morning. To Don and to the families of the classmates whose passing we have reported, your Secretary expresses the sincere sympathy of the Class of '26.

It's an abrupt change to our next statement but this is the December issue we are writing on a beautiful October morning at Pigeon Cove so we extend Christmas Greetings to all and say cheerio until 1973.—**George Warren Smith,** Secretary, P.O. Box 506, Pigeon Cove, Mass., 01966

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Charlie Smith writes that he has been talking with a few of our classmates about the possibility of a group trip by '27 members and their wives to Italy and Greece in the spring or fall of 1974. He is talking in terms of a trip of about three weeks, to cost in the neighborhood of $1,000 per person. Any classmates who are interested should write directly to Charlie: Charles C. Smith, 6780 Tupelo Lane, Cincinnati, Oh. 45243. . . . My apologies to **Don** and Hilda **Wylie.** In the story of the Reunion last month, her name appeared as "Helen."

Erik Hofman continues to schedule an annual sea voyage from his retirement home in Mallorca, Spain. In 1972 it was to Buenos Aires and back from Lima via Panama. For 1973, he is planning to sail around Africa to Portuguese East Africa, Mauritius, and Reunion, then back to Mallorca.

The questionnaires returned with the Reunion reservations give a fascinating glimpse of the post-retirement activities of some of our Class. Most of us have been unwilling to sit back and let the years creep up on us. Any number report part or full-time consulting, and corporate directorships. Others have taken to civic activities—Red Cross, several historic society trustees, trustees of the library, or arts council, or safety council, Alumni activities, neighborhood centers, ecology activist groups, church work, SCORE. . . . **Jim VanDerpool** has continued as co-chairman of the Save Venice Committee of the International Fund for Monuments. . . . **Larry Cheney** is still teaching adult education classes in caning and rushing, and in Early American decoration. . . . **George Cunningham** is continuing his studies in ceramics at California State University at Long Beach and is organist at Moulton-Laguna Playhouse.

Leroy Miller, who spent a year in Liberia as maintenance engineer for the Lutheran Church's high school in that country, lectures on his African experiences. . . . **Phil Rhoads** is assistant superintendent of Schools for Business in the Wilmington, Del., public schools. . . . **Dave Knox** is painting, and writing a second book; **Erik Hofman** is also author of one published book and working on a second; **George Houston** and **Hank (Franklin T.) Kurt** are both writing for publication. . . . **Johnny Drisko** is still working as chief project engineer of the Tarbela Dam Project in Pakistan, which will be the world's largest fill dam. Planning for the dam started in 1960 with construction in 1968. Johnny is planning to stick with it until completion, scheduled for 1976.

There are those who report their retirement activity as sports and hobbies—golf and photography are the most common. **Bill Taggart,** whose retirement is still quite recent, says he keeps busy with grocery shopping and housekeeping. One member of our Class, who shall be nameless, says that his post-retirement activity is chronic alcoholism. . . . **R. Moen Smith** is raising orchids in St. Croix.

The information from the questionnaires is quite sketchy and too many of the Class failed to return them at all. Your Secretary would welcome news of what you are doing, and of other members of the Class you meet or hear from.

Some of the following address changes sound as if they denote a change in activities: Constantine Bary, Four Views, Box 161, Ft. Washington, Pa.; E. Stanley Bogert, 520 58th St., Holmes Beach, Fla.; Elwood A. Church, 8003 Seminole Blvd., Lot 28, Seminole, Fla.; Daniel C. Metzger, 750 No. Ocean Blvd., Pompano Beach, Fla.; Herbert Parkinson, 6455 York Ave. #211, Edina, Minn.; Emory F. Patterson, 35 School St., Brunswick, Me.; Captain Leland D. Whitgrove, P.O. Box 366, San Luis Rey, Cal.; Miss Hilda Young, P.O. Box 106, Gambier, Oh.—**Joseph H. Melhado,** Secretary, 24 Rodney Rd., Scarsdale, N.Y. 10583

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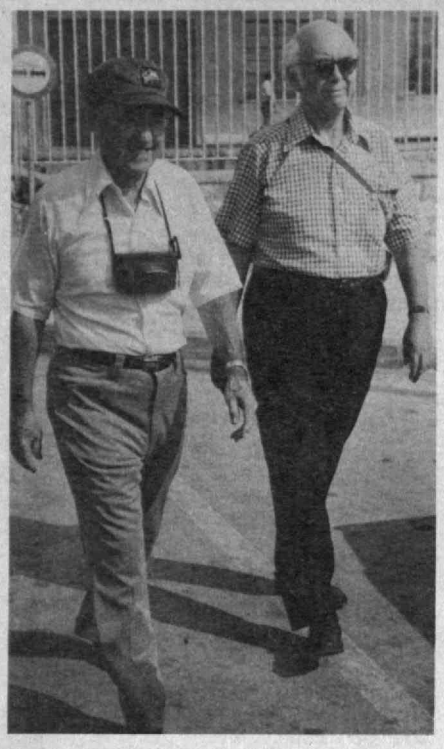
May we start by wishing each and every one of you a very happy holiday season! One of the nice things that can happen to a Class Secretary is to receive a surprise letter from someone who has never written to him before. This time our benefactor is **J. Armand Monier, Jr.** At the end of last year Jay retired as plant manager of the A.E.C. Savannah River Plant in Aiken, S.C. He had held this post for five years. Prior to that he was assistant manager for ten years. The plant is operated by the duPont Company where Jay served for a total of 38 years. Jay says the plant area is so large (310 square miles) and so closely restricted to access that it has become a wild-life preserve. The deer alone number about 8000 head and have to be controlled by harvesting about 1000 of them annually through hunting.

During his service as manager, the Savannah River Plant set a record of 34 million man hours of work without a lost-time injury. For this, Jay was presented a trophy. The presentation was made by Glenn Seaborg, then head of the U.S. Atomic Energy Commission. Now Jay has bought a home in St. Petersburg, Fla., located on a canal where he has a dock and boat. He expects to divide his time between salt-water fishing and golf. Later he and wife Van plan to do some traveling. The Moniers have three children. The older boy is teaching and working in Portland, Or. Daughter Dianne is a registered nurse in Evanston, Ill., where she shares time between her three children and her professional career. The younger son operates two filling stations in Atlanta, Ga.

Lazare Gelin sent in a picture post card from Cortina d'Ampezzo, Italy, showing some remarkable scenery. He wrote "I am now retired from business and do just a few consulting assignments. We have spent three months in Italy on the lakes and now we are winding up our stay here. Next we will go to Austria, Switzerland and then home in the fall." . . . Some of your local (Boston) class operators spent a very pleasant day in



Last summer Robert Peatfield, '28 (left) and Frederic Nordsiek, '31 met on an Alumni Flights Abroad tour (one of the Technology Review's *regular advertisers.) The candid cameraman of the M.T.S.* Apollo *caught them coming ashore at one of the Greek Islands. Engineering and Science keep in step, but with Engineering out in front!*

August visiting Dorothy and **Herm Swartz** at their fruit farm in New Hampshire. Frannie and **Jim Donovan, Florence Jope,** and your Secretary joined the Swartz's for a day of activity that included picking blueberries, gathering apples, and swimming in the farm pond.

The newspaper of September 21 in Winchester, Mass., carried the news that "Mr. and Mrs. Hugh Virgo-Williams of England announce the engagement of their daughter, Sarah, to Lieutenant Theodore W. Jope, son of **Mrs. Ralph T. Jope** and the late Mr. Jope. A winter wedding is being planned." Ted is a communications officer aboard the U.S.S. *John F. Kennedy* and was recently on duty in the Mediterranean Sea. . . . Another Floridian is **Don Fraser** who wrote enclosing a newspaper clipping from the *St. Petersburg Times* of May 16. This was relative to Luis Antonio Ferre, '24, Governor of the commonwealth of Puerto Rico. The item reminded Don that Governor Ferre's brother Carlos was our classmate. Carlos died in 1958 just prior to our 30th Reunion. For his own part Don reports that he is treasurer of the Anna Maria Island Garden Club and assistant secretary of the Island Power Squadron. The rest of his time is taken up with grounds-keeping, boating, and attendance at luncheon and dinner meetings of the South Florida M.I.T. Club in Sarasota. **Bill Hurst** will be pleased to know that Don agrees with his views expressed in the July/August Class Notes. . . . A news release of September 18, 1972 from the consulting firm of Camp, Dresser, and McKee announces its merger with Alexander Potter Associates, the latter becoming a subsidiary firm. In the new arrangement, **Morris Klegerman** serves as president of A.P.A. and **James Ure** serves as a vice president. Both firms are engaged in environmental engineering.

We regret to report at this time the deaths of two classmates. **Charles F. Haberstroh,** Course X, died on August 28, 1972. Charlie was employed for many years as a chemist at Lever Brothers Company, then in Cambridge, Mass. During World War II he served with the U.S. Army on field tests at Dugway Proving Grounds in Utah. Later he worked for the military as a government inspection officer. In 1968 he retired with the rank of Lieutenant Colonel, U.S.A.R. He leaves his wife Anastasia, a daughter, three sons, and six grandchildren. . . . **Kenneth J. MacKenzie,** Course X, died of a heart attack on August 15, 1972. Kenneth joined Eastman Kodak Company in 1927, took time out to study at M.I.T., then embarked on a highly successful career to meet the special papermaking needs of Kodak. In 1945 he won the Bolton Award of the American Pulp and Paper Mill Superintendents Association. He retired in 1968 as superintendent of the paper mills division at Kodak Park. We extend our sympathy to his wife, Beatrice. —**Walter J. Smith,** Secretary, 209 Waverly St., Arlington, Mass. 02174

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John S. Saloma, a member of the M.I.T. faculty as a political scientist and public affairs consultant, has written a book, *Real Opportunity for Effective Citizen Politics* with Frederick H. Suntag as co-author. "Is there a future for political parties in America? Can they channel the energies of an increasing independent electorate toward the solutions of such pressing problems as war, inflation, poverty and racial strife?" The answer, according to the author, is a resounding "yes." The book has drawn favorable comments from the political leaders of both parties and other political analysts and writers.

Ezra C. Hill of Fort Wayne, Ind., writes, "I have just attended my 45th Class reunion at Purdue University. Dean Andrey A. Potter, '03, one-time acting president of Purdue, who is in his 92nd year, spoke briefly at 15 class breakfasts. I am now doing consulting work for G.E. Since retirement I have done similar work for Xerox and Fighton." . . . Received another postcard from **Hunter Rouse** of Iowa, who is on a lecture tour of South America with his wife, "We are on our second leg of a lecture tour. After two months and visiting six countries, we are back to Iowa City for rest. Quito, Ecuador is a charming place, day or night—it leaves you breathless (9300 feet elevation) in more ways than one."

John D. McCaskey of St. Joseph, Mo., attended the Mexico City Fiesta last March hosted by the M.I.T. Club of Mexico. "It was my first meeting" he continues "but it won't be my last. I had a delightful time and I highly recommend it to the rest of you Twenty-Niners. I am 64 years young and still going strong."

A sad note comes from the widow of **Harold E. Ford,** Hindsdale, Ill., "My husband passed away on June 17, 1972 after an illness of 10 weeks. He had just retired and was looking forward to taking life easy. We were married when Harold was still an undergraduate, on February 9, 1929 (it just wasn't done in those days.) We both had many friends in the Class of 1929." After graduation, Harold joined his father's firm in general contracting around the Chicago area. He enlisted in the navy during World War II, building submarines. Upon his discharge from the navy in 1945 he had advanced from a Lieutenant to a full Commander. He joined his brother in forming Ford Brothers, Inc., General Contractors, doing business in and around Chicago. In December 1969 Harold had a serious automobile accident which forced him to retire from his contracting business the following year and become a real-estate broker.

On Alumni Day last June, there was a display of pictures entitled "Oldtimers", among which was a snapshot of **Ruth Davies Van Wagenen** fencing. Ruth writes, "I was a trifle shaken up to realize that I had reached the age of 'historic interest' at M.I.T. True, my hair is gray, and I have a few wrinkles, but I really don't feel *that* old as yet. I have sold my house in Skaneateles, N.Y.—a wrench to leave this beautiful spot. I shall return to Santa Barbara in September, but plan to come to the East each spring to visit my family and friends. About the pictures —guess we coeds were history in those days—550 men and six girls in my graduating class."

Walter H. Partridge of Andover, Mass., writes, "You are doing a great job as our Class Secretary. I retired this week from the U.S. Marine Corps, after an association of nearly 41 years. For 20 years, I was plant engineer at their Cambridge, Mass., plant, designed some of their process machines that are still in use today, as well as some consume applying machines. In 1957, I was appointed their chief engineer and I have been involved since that time in the establishment of their chemical plants in Cambridge, Montreal, Tennessee and Michigan. The major products of these plants are quality adhesives and footwear items. My wife, Dorothy, also retired a month ago from a teaching career that spanned over 40 years. She was connected with the Andover school system for 32 years as a teacher, a junior-high-school principal, and for 12 years as a school committee woman, when our children were young. We have two children, both married. Joy, a Vassar graduate and former teacher and David, a Princeton graduate who is engaged in banking business in N.Y.C. I still belong to the Andover tennis club and occasionally enjoy a doubles match. However, since I received a set of golf clubs at a company retirement party, I will take the hint and change to the more leisurely sport."

Norman J. (Bert) Eich of Placitas, N.M., writes, "Retired from Bell Telephone Laboratories after 40 years as of December

31, 1970. I chose that date so that I could celebrate my freedom from the scheduled life on every New Years Eve. Had been on assignment to Sandia Corp., since 1953, which accounts for my New Mexico address. My only regret is that I didn't move here sooner. Retirement is the least boring assignment that I have had in my life. I am enjoying it so much that I don't even want a vacation from it. I do take some civic duties on a strictly non-schedule basis. I am out to pasture and the pastures here may not be very green, but there is lots of room to enjoy life. More power to you who are still working for the good of the Class." . . . **Rodolphus A. Swan** of Wolfeboro, N.H., has retired from Sylvania Electric Co., after 43 years. He spent 17 years with the company as an engineer in the design and production of black and white TV picture tubes in the Salem, Mass., plant. In 1949, he was promoted to assistant chief engineer in the making of black and white and color picture tubes, in the Seneca Falls, N.Y., plant. After retirement in August 1971, he continued to serve the parent company (G.T.E.) as a consultant until June 1972 when he purchased a retirement home in Wolfeboro, N.H. He and his wife, Rhoda are well and enjoying their retirement by taking trips to Europe and South America.

Frederic D. Merrill of Chatham, N.J., writes, "Your birthday card reminds me that I am not getting younger with each passing year. I have not as yet retired from my teaching job. I have written and had published a monograph on the unit step function and its application to simple electrical circuits.". . . **Norman M. Wickstrand** of Harwinton, Conn., writes that he has been retired from the Tarrington Co., for the past two years, though he is called upon to do some consulting for the company. He is active in several conservation organizations and is teaching one course in mathematics at the University of Connecticut. He may teach statistics starting next year. Last March, while he was on a hike, he fractured his ankle and had to be rescued by the Volunteer Snowmobile Emergency Unit.

Vincent F. Gardner of Belmont, Mass., writes "You are doing a great job of keeping our diminishing group closely knit together. I am now semi-retired. I find it very difficult to face a situation where I would have nothing to do. I am seriously thinking of doing part-time consulting and advisory service in the field of hospital maintenance engineering. Hospital engineers sometimes confront sudden and difficult problems, requiring immediate solution. Twenty-five years in the business enables me to give advice on some such problems based on experience. Regards to all." . . . **Paul V. Keyser,** Shelter Island Hts., N.Y., was recently elected a member of the M.I.T. Corporation. He is the second member of our Class to be so honored, first being **John J. Wilson,** who is also Secretary to the Corporation. Paul was also a recipient of the Bronze Beaver Award during the Alumni Officers Conference at M.I.T. on October 6-7, for meritorious service rendered to the Alumni Association. Paul just finished two one-year terms as President of the Alumni Association.—**Karnig S. Dinjian,** Secretary, 6 Plaice Cove, Hampton, N.H. 03842

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In early October your Secretary attended the Alumni Officers Conference in Cambridge and an impressive program, reported elsewhere in this issue, was presented. The Class of 1930 was only sparsely represented. **Otto Zigler,** the only other full-time attendee, came up from Timbersville, Va., where he is living on the family farm and enjoying his retirement. Otto has received a Memento of Appreciation for his work on 1972 Alumni Fund. . , . We learned from **Greg Smith,** who attended some of the sessions, that he retired from Eastman Gelatine as of September 1, 1972. He has long devoted substantial amounts of time to non-business activities and finds that he is having trouble deciding how to allocate the free time now at his disposal. . . . **Parker Starratt,** after having obtained an M.B.A. at Lehigh, has moved to Hancock, N.H., and is teaching in the Business Administration Department of Hawthorne College. The Starratt's son Peter is at the University of Pittsburgh starting work on his master's degree in Public Health Administration. Daughter Priscilla is at University of Michigan working on a Ph.D. in African history. For you amateur radio addicts, Parker says the F.C.C. has restored his former K1BUR radio call and he has put up a 65 foot foldover tower for H.F. and V.H.F. work. He is throughly enjoying New Hampshire and would be pleased to see any classmates who may drive up that way.

Walter Soroka has been named by the California Legislative Assembly to serve on an advisory committee on pollution and noise. . . . **Fred Holt,** as many of you know, is executive vice president of Brown-Bridge Mills in Troy, Oh. He is looking forward to retirement next year. He owns some beach-front property on the island of Grenada and plans to divide his time between Cape Cod and the Caribbean. Fred's company merged a year ago with Kimberly-Clark for whom he worked briefly right after graduation. His comment: "It took them 40 years to find me, so they could not have been looking very hard." The Holt's daughter, April, attended Knox College and University of Cincinnati. She now has a master's degree in clinical psychology and does rehabilitation counselling of retarded, emotionally disturbed, and drug-addicted patients. . . . **Tom Hickey** is director of the Mechanical Engineering Examining Group in the U.S. Patent Office. He reports that **Sam Koren,** also a patent examiner, retired in June 1972. . . . **Dwight Horton** is a rancher in Fischer, Texas and also does some consulting work in the field of sewage percolation and sanitary land fills.

Tul Houston has recently relocated both his home and his office. The new home is still in Short Hills at 62 Slayton Dr. The new office is in Bloomfield, N.J., where he operates under the name David T. Houston Co., Industrial and Commercial Realtors, Appraisers and Consultants. He has a staff of 12 men, including David Jr., who recently joined him after spending three years in the navy as engineering officer on a destroyer and then getting an M.B.A. at Columbia. The Houston's daughter, Cynthia, graduated from Hollins College, '69, spent a year in Vista and then obtained a master's at Northeastern. She is now teaching psychology at New England Agricultural and Technical College and also counselling at North Shore College (Mass.) She was married September 30 to a B.U. theology student. Younger daughter Anne is a freshman at Bucknell. . . . Tul says he has recently seen **Jack Osborne,** who retired from M. W. Kellogg Co., but has continued to work for Kellogg as a consultant and is now in Brazil on a refinery job. . . . He also reports **Bob Reynolds'** retirement to Cape Cod. Tul is much impressed by the fact that the Sigma Nu house now has women in residence. His comment: "Ah women! Amen! We was robbed."

Changes of address: William E. Cullinan, Jr., Pilot Point Rd., Cape Elizabeth, Me. 04107; Wilfred P. Eaton, 5047-C Val Verde, Houston, Tex. 77027; Charles G. Habley, 1050 Crestview Dr. #14, Mt. View, Cal. 94040; David T. Houston, 1025 Broad St., Bloomfield, N.J. 07003; Frederick Trescott, RD #1 62 Heather Hill Dr., Marshfield, Mass. 02050; A. Sol Uman, 166-25 Powells Ave. Blvd., Beechhurst, N.Y. 11357; Parker H. Starratt, Duncan Rd., Hancock, N.H. 03443; Wesley W. Wedemeyer, Wedemeyer Cernik Corrubia, Inc., 611 Olive St., Rm. 1770, St. Louis, Mo. 63101—**Gordon K. Lister,** Secretary, 530 Fifth Ave, New York, N.Y. 10036

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Plans are progressing for our Mexico Mini-reunion. So far, a total of sixty-one people have made firm reservations. A complete itinerary for the three-day fiesta will be sent to each of you by the M.I.T. Club of Mexico City, sometime in the near future.

If you are planning to travel to other parts of Mexico before or after the Fiesta Weekend (March 15, 16, 17) you should now be making travel and hotel reservations through your own travel agent or Heritage Travel, Inc., 238 Main St., Cambridge, Mass. 02142. A list of those classmates who will be at our Mini-reunion will be sent to you in December.—**Edwin S. Worden,** Secretary, 35 Minute Man Hill, Westport, Conn. 06880

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The Alumni Officers Conference at the Institute, October 6-7, 1972, provided an opportunity for an informal meeting of your class officers **Don Whiston, George Kerisher** and your Secretary, and the pleasant news that **John Finnerty** has accepted the responsibility of the Class Agent. John is looking forward to the continued support of the Class of 1932 that you gave to his predecessor Tom Sears.

Charles McCoy, Chairman and President of the DuPont Co., made national news with his recent article "What's right with

business?" in the Fall 1972 issue of the *DuPont* magazine. Context: a most interesting and informative view from one of the country's top industrial leaders. Charles is also serving on President Nixon's National Industrial Pollution Control Council. . . . **F. Rolf Morral,** after many years with the Battelle Memorial Institute in Columbus, Oh., has settled in Barcelona, Spain and has undertaken "an ambitious program to find funds and organize the First International Congress on Mercury in September, 1973, here in Barcelona." This is in addition to his own private "people to people" program at the Emillo Jimeno Instituto Tecnologico Metallurgico which is modeled after the Battelle Memorial Institute. Rolf says the latchstring is always out for any classmates visiting Barcelona.

William Liben was a recent contributor of a co-authored paper in the A.P.L. Technical Digest published by the Applied Physics Laboratory of Johns Hopkins University on "An Argon Laser Photocoagulator." The paper describes the instrument developed by the Applied Physics Laboratory—Wilmer Institute cooperative group, reviews the experimental observations in animals and tabulates the clinical results in the treatment of patients with retinal vascular and macular diseases. . . . **Earle Hiscock** is helping to speed-up coffee-break time with a new patented package for perking a single cup of coffee. This is in addition to his previous patents on a wind-direction and velocity weather vane—a new type sailboat rig.

John Northup was recently named vice president in charge of manufacturing of Owens-Illinois, Inc., Toledo, Oh. . . . **Harold Tonsing** has joined the "pacemaker" set and at last reports doing just fine. Your new Secretary is completely indoctrinated and joins the hue and cry of all Class Secretaries awaiting your news, views and activity reports. Let's hear from you.—**John W. Flatley,** Secretary, 6652-32nd St., N.W., Washington, D.C. 20015

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Lest we forget, Leona and I send our very best Christmas Greetings to y'all. For me, please send class news!! It is fortunate that we appear to have some news though far from the amount I always need. First comes **Cal Mohr,** who participated in the welcoming of the president of the Filtration Society of England, to the Chicago chapter. The distinguished visitor and his wife were entertained at a real American barbeque. . . . From **Beau Whitton** comes a welcome bit. Daphne and he will surely attend the 40th; Westy please make a note of it. Beau and Daphne are planning to take a long trip, visiting Alabama, Mississippi, Louisiana, Texas, New Mexico, Colorado, thence back through Missouri, Kentucky, and Tennessee. This ought to be a prolific source of post cards. Beau, see note above to Cal Mohr. It appears that Southeastern Construction Co. did work running into 8 figures, building for Disneyland, and Beau modestly agrees that the place would not have opened on time without him. Beau, did you see any classmates named General Potter while there? Beau sent me a photo of a new plant he built for S.K.F. in Asheville, N.C.

Now comes **Art Mason,** who wishes to straighten us out on his physical condition. In a recent issue of the *Review,* Art says news of him reads like an obituary. Well, Art, you never did much writing to me, so I just had to use what I got elsewhere. It appears that Art's arthritis is no bargain but he sometimes enjoys a spell of relief, longer than the bad spell. Art's letter seemed quite cheerful. Art's physician tells him that he "found a trace of blood in his alcohol stream!" My, My! Did I say that the guy is cheerful? The Masons are soon to celebrate their 33rd wedding anniversary. Swell, Son—give Leona and I another eight months and we will be married 50 years. Any of y'all that wish an invitation, you just might get one by writing Leona. Wife, Dot, has been most patient and understanding through all of Art's troubles. Son, Tom, is a grad of the University of Delaware, '66, and daughter, Jan, from Miami (Ohio) University, '68. They also recently acquired a new daughter-in-law, Nancy. Art, many thanks to you and to yours.

Meyer Shnitzler lives during the winter in Fort Lauderdale, and finally decided to drop in at 1079 for a wee drappie. Meyer retired from Gilette five years ago. He remarried four years ago to an Irish girl who taught at Boston State College. This fella really rides his hobbies. First, he is a beach-scanner, which consists of using the usual metal detector and much gossiping en route. He has beached the whole west coast of France, along the Channel and then on to Copenhagen. Directly after that, he went to southwest England, along the south coast—Land's end to Margate. I was unable to determine what he enjoys more, the scanning or the gossip. Meyer has still another hobby—watch and clock repairs. I quote him, "Both social and technical, the ramifications of this hobby are enormous." Now, Meyer, you know we all love ya, but, what is so social about fixing a Big Ben? Meyer, now hear this, you get to 1079 between November 20 and January 1, or you get no noggin. Mamma and I take off on a cruise for three months, and you must then perforce drink your own.

I report two postcards from **Walt Skees,** mailed in Español. . . . From **Ellis Littmann** comes two fine notes. The first gives us the story of Roz, Ellis, and daughter Susan on a charter flight, Missouri Athletic Club sponsored, to Sweden, Helsinki, and Copenhagen; four days in each, plus flight time from St. Louis and returned non-stop both directions. Ellis says that, properly sponsored, these chummy charter flights are really something, and they all enjoyed it immensely. As Mr. Golden has said, "Enjoy, enjoy". Ellis says that they did not even touch their baggage outside their rooms, portal to portal. The other letter was sent after the recent Alumni Officers Conference. Ellis and Jim Turner held a Fund meeting and arranged a telethon for later in November. Besides Jim and Ellis, Westy attended, as well as **Bob White.** . . . I am informed that **Jim Turner** is to get out his annual letter far before you read this. It is usually the state of the (His) nation.

Horace MacKechnie sends a note and some clippings that Prue has collected about a book written by their talented nephew, Eliot Wigginton, about Foxfire, and called *The Foxfire Book.* You will recall that *Foxfire Quarterly* magazine is put out by a most unique high school in Georgia. Mr. Wigginton went to this location to teach at the high school. Soon after, the Foxfire magazine was born, written by the students, from material gathered by them. From the magazine came most of the material that has been included in the new book about Folklore in north west Georgia. Horace's mother-in-law recently passed away at 93 and oldest daughter Margaret has recently remarried. Horace is still in the same business, saving defense money, in Defense Product Engineering, formerly Engineering Value Engineering Service Office. He says, Christmas letter next! Horace, please tell me how to get an autographed copy of that *Foxfire Book.*

Our own **Horace Beattie** has been made a vice president of I.B.M., and continues as vice president in charge of engineering for I.B.M.'s Office Products Division. Horace began with I.B.M. right out of school and advanced from customer engineer to senior engineer, several management jobs, and then became manager of the engineering lab at Poughkeepsie. In 1957, he was transferred to Lexington, Ky., as head of the office of products engineering and in 1967 was made division vice president. You will surely recall that Horace recently received the A.S.M.E. Medal for "eminently distinguished achievement." Horace, we admire you no end. . . . We have a nice card from the **Robert Timbies.** Bob says "after a three-month bout with illness, we took off for the mountains." The card came from the Smokies, "where we find it cool and beautiful." It sure is great to hear from a mechanical engineer who is also a proven mechanic. The only difference between me and Bob is that he is a far better engineer. Now come the short but sweet Alumni Fund capsules, and, speaking of fund, don't forget the 40th Fund, a project that just must go over.

Bill Pleasants, proven professional engineer, announces that the next project is a water-treatment plant in Panama. You will recall that Bill operates in Puerto Rico, Delaware, and now Panama. Bill, I do hope that you can find a minute every so often to bring us up to date on your most versatile career. From **Charlie Miller** comes this, "See announcement of my appointment in *Tech Talk,* March 15, 1972, Vol. 16, #36, Page 7." Charlie, if you had told me when this happened, it would now be on record. . . . As I live and breathe, here's a bit from good ol' **Bill Huston,** where he thanks Warren and Leona for his good visit to Hillsboro Beach. Say, here's one: "Our second granddaughter was born on my birthday, October 2, 1971, named Alex." . . . **Mal Mayer** says that he has become involved with S.C.O.R.E. in Maine and will be there until December, then to New Zealand for Christmas. The Mayers have a child there, temporarily, complete with grand-

children. Write, please from New Zealand. We will be there in February.

We have quite a few address changes: Arnold M. Fedde, M.E.; Ernest Butkus, C.E.; Kenneth A. Devine, M.A.; Mrs. Clyde A. Dively; Maurice G. Green, C.M.; Dr. Norman Levinson, E.E.; Lennox H. Lindsay, C.H.; Ellis C. Littmann, M.G.; Prentiss Lobdell, S.L.; James Loughman, M.E.; Kenneth D. Moslander, M.G. These new addresses are available with the usual string tied to the request.

Three of our fellows have passed away since our last; **Robert B. Mills,** on June 5, 1972; Antonio De Lorenzo, on June 20, 1972; and **J. Dyer Potter, Jr.,** on September 4, 1972. The sympathy of the entire Class goes out to the loved ones who remain, and with my personal respects. We have written the surviving widows, or will, in the name of the Class.

The 40th Reunion is now only eight months away. When you are sure of attending, or if you have any questions, write directly to: **Clarence R.** (Westy) **Westaway,** 247 Commonwealth Ave., Boston, Mass. 02116. . . . Again, our best wishes for a very Merry Christmas.—**Warren J. Henderson,** Secretary, 1079 Hillsboro Beach, Pompano Beach, Fla. 33062

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As I mentioned in the last issue, I was saving some of the Alumni Fund notes for this month. So let me start with them. . . . From an enthusiastic **Phil Kron,** "Retirement is great! Bought a winter place on the ocean at Hillsboro Beach just north of Pompano Beach on A-1-A. Spent three wonderful months there this winter, with lots of golf! Our youngest son John and his wife Kathy both graduated from Colorado University in May. They are settling in the Denver area."

I have mentioned some of the professional accomplishments of **Jerry Raphael** before in the field of reinforced concrete, but as you can see, he's also having fun with it. He says "In addition to picking up my share of the hardware on my racing sloop, I've talked my A.S.C.E. student chapter into building a ferro-cement canoe which they will race against three other California colleges in the 4-C's—'California Concrete Canoe Classic.'" . . . **Larry Stein** writes, "With two children married and one in college, we now have only one at home. Expect to have a family reunion at P.E.I. in July, where we are going to see the total eclipse of the sun (our 3rd one)." **Harry Fine** tells us that he is the assistant chief engineer in charge of the research division of the F.C.C. . . . **Harold S. Adams** writes that he is an associate professor of Environmental Health in the Department of Preventative Medicine, Indiana University School of Medicine in Indianapolis. He is also secretary of the ScienTech Club in that city and a Fellow of the American Public Health Association.

From George Woodman, "I retired in mid-June from my job of supervising naval architect at Portsmouth Naval Shipyard. My wife Audrey and I have built a retirement home on the York River and we plan to do a little cruising on the coast of Maine this summer." I wonder if he and **Ted Taylor** get together much. They're both '34, both worked at the shipyard, and both are interested in boating. . . . **Andrew Dempster** tells of spending a career working on "new and used" water. After 31 years with the City of Detroit Health Department, he retired in Nov. 1966 from the position of director of the Bureau of Sanitary Engineering. He then spent three years with the National Sanitation Foundation as project director on wastewater technology. Andrew resigned from that position in May, 1970, and then took off on a round-the-world trip via air to England and Russia, the Trans-Siberian Railroad to the Sea of Japan, ship to Japan, thence by air to Hawaii and Michigan. This did not kill off the wonderlust, however, because he travelled 5000 miles in Mexico by railroad in 1971.

My last fund note has a sad sequel. In May, **Frank A. Nicoli** wrote: "Retired as vice president of Ley Construction Co, Springfield, Mass., this year to a well-earned life of ease and comfort with my wife Maria. Son David graduated M.I.T. '66 receiving Ph.D. at Harvard this year and son Tony a master of Fine Arts from Rutgers in June." In September, **Frank Conti** sent me a clipping of Frank Nicoli's death. Such a shame that he was not to enjoy the retirement he was looking forward to. We extend our sympathy and regret to Mrs. Nicoli and her sons.

In Galveston, Texas, **Morgan Campbell** retired in June after 41 years with the Corps of Engineers. At the time of his retirement, he was chief of the design branch of the Galveston district. Mr. Campbell had received a B.S. from Rice and his M.S. from M.I.T. in 1934. During his career he had been concerned with several major hurricane flood-control projects and had supervised the design of the Gulfgate Bridge at Port Arthur, which was selected as an "Award of Merit" winner in the 1971 Prize Bridge National Competition conducted by the American Institute of Steel Construction.

These notes seem to be heavily weighted towards the CE's this month. In August, **Martin F. Cosgrove,** was appointed administrative engineer of the Boston Metropolitan District Commission. Mr. Cosgrove is a recognized authority on water resources and water pollution control and in his new post he will oversee all engineering functions of the M.D.C.

I was sorry to get a letter in August from **Irvin Gahm** telling of the loss of his wife Berenice, in July. She had married Irv in 1934 and they had been at Pearl Harbor when the attack came. She had been honored for her bravery in organizing help under fire. In recent life she had been a tournament bridge player and active in Hadassah and volunteer work for several hospitals in the Boston area. This, unfortunately, was another death that came when the Gahm's had started plans for retirement. I would express the sympathy of all of us to Irv on his loss.

I was able to attend the Alumni Officers Conference at the Institute in October and was pleasantly surprised to see **Jim Eder** and his wife, Mary. They were on their way to Maine to visit friends. Apparently, the air boat business is a thing of the past and they are beginning to think of places to retire to; Florida not being quite what they want. . . . This should be reaching you before Christmas. May it be a good one for all of you and may the New Year keep you in health and happiness.—**Robert M. Franklin,** Secretary, Satucket Rd., Brewster, Mass., 02631; **George G. Bull,** Assistant Secretary, 4961 Allan Rd., Washington, D.C. 20016

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One of the pleasant mid-summer surprises was in receiving a phone call from **Charles Piper,** who was staying at the Marriott in Newton. We met for a couple of hours of drinks and conversation. Charlie was visiting from the Los Angeles area where he "has lived in the same house for 15 years". T.R.W., Charlie's employer for the past ten years, is managing a Minuteman contract at Sylvania in Needham and he is the liaison man on the job. Prior to T.R.W., he was with Bendix Computer for five years, the company that took him West. Charlie would like very much to hear from **Lars Sjodahl** who is currently in Cincinnati at 1549 Wittlou Ave. Charles Piper lives at 26810 Fond du Lac Rd., Rolling Hills, Calif., 90274. Lars, please write and send me a copy.

You will be interested in learning that **Sid Grazi** won the twelfth annual Class Golf Championship and the first leg on the new President's Trophy pictured in last month's *Review*. It is being engraved and will be sent to Sid to put on his mantelpiece for a year. I had managed to win my second-round match against **Dexter Clough** in Bangor, then edged out **Sam Brown** in a memorable match at Canoe Brook to get into the finals with Sid. We played at Columbine in Denver (a neutral course) and it was a close match all the way with Sid winning the last two holes to end it. In the consolation flight, **Bill Bates** had his best round of the year, an 86-63 to beat out **Ned Collins** in a match played by mail. I played with **Leo Beckwith** and **Bob Forster** when they had their match at Kernwood, but my plans to play with other classmates fell through when my travel budget was trimmed.

I guess I never did tell all of you that I separated from Astrodyne last March and have been doing marketing consulting work for Atlee since. Atlee is the company I started in 1951 and lasted for 12 years before being forced out. I was welcomed back by new owners and new management. . . . Here are some notes received in answer to Bob Forster's questionnaire. **William Barker**, now of 4402 Mars Ct., Orlando, wrote, "After the '70 cost squeeze in the paper manufacturing industry forced a major cut at Ethyl Corporation's Oxford Paper R&D staff, Mae and I took a giant step south to Orlando. The idea was to slow down and enjoy more golf. However, real estate activity in Central Florida—adjacent to Disney World with thousands of new residents—makes a slow pace here impossible. Result: less golf plus a six-to-seven day work week. It is stimulating to meet

so many nice people "coming down" though. Thank Goodness Mae and I are healthy, if not wealthy or wise. Best to all."

Arthur Cohen writes from Waltham, "My daughter Eileen was married May 28 and received her Ph.D. in Anatomy at Harvard Medical on June 15." . . . **Eugene Schwarzenbek** writes, "Entered private consulting business in 1965. Call myself a process consultant, servicing petroleum, petrochemical and chemical industry. Working on your own presents its problems, but I enjoy it. Office is in Toms River, N.J. Live on ocean—3 Seacrest Dr., Lavallette, N.J. 08735." . . . From **Jack Orchard** comes this note and letter. "Six 'kids' (36, 34, 34, 26, 13, 11), four grandchildren (8, 8, 5, 3). Now on staff of American Revolution Bicentennial Commission. Ex-yachtsman because Jimmy, 11, and Johnny, 13, have become competitive swimmers, golfers, baseball players—plus, boss Helen's many memberships on boards and committees. Took up golf again and quickly raised handicap from 14 to 18. Still the same old Apple-Jack but perhaps a little more mellowed." I would also like to pass along Jack's letter entitled "Other Recommendations." "We're now in the Bicentennial Era and most of us old fogeys were brought up under the spirit of '76. As parents we inculcated the spirit in our kids but the faculties of schools didn't do their part with them as they did with us. M.I.T. is most blameful in this respect. As grandparents we're hopelessly witnessing a steady decline of this spirit. Perhaps we could use the Bicentennial as a rallying point to re-enlist the support of the faculty. I talk not about fireworks and parades. I talk about a regeneration of a basic American philosophy. My program is broader than the secular 40th Reunion in 1975 of M.I.T.'s Class of 1935. This is a nationwide problem. The solution must be bipartisan and one that bridges the generation-plus gap. I'd be glad to work up some implementation details for review before and discussion at the 40th Reunion. This could make our Class of '35 the nationwide impetus for *this* Bicentennial program for 1976 *et seq.* It's time, not money, that's required. Given a dedication of time from retirees or about-to-be retirees, the funding of a successful program would be self-generating." Jack's address is Emory Lane, Rockville, Md. 20853.

Walter Stockmayer wrote a quick note: "Sylvia and I are on a Sabbatical (working) in Holland until November 20 or so." I was delighted to read Stocky's P.S. "I even tolerate all the golf stuff!" . . . **Thomas Blair,** Eatontown, N.J. writes, "Retired from Civil Service job at Fort Monmouth two years ago. Taking life easy." . . . We will use another lot of these messages next month. In the meantime I thought you would be interested in this from the Brookline paper about **Gerry Golden.** He is serving as machinery and equipment section chairman of the United Fund campaign. The article goes on to say, "Golden, President of Langley Handling Equipment Co., has served the United Fund in previous campaigns. He is a member of the Smaller Business Association of New England, Vice President of Associated Handling Equipment Dealers, and a volunteer of the Mass. General Hospital. Mr. and Mrs. Golden and their three children live at 83 Hammondswood Rd., Chestnut Hill." A very merry Christmas and happy Hanukkah and New Years to you and yours.—**Allan Q. Mowatt,** Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

36

A note from President **Tony Hittl** tells of the trip he and Marian made to England and Scotland early in the summer. He writes: "Took the *France* over and the *Queen Elizabeth* back. Visited as much as we could squeeze into three weeks by car, train and bus. We especially enjoyed visiting with some English families in small towns west and south of London, including Bath, Stratford-on-Avon, etc. I have a list of 32 homes which I could forward to anyone interested. We stayed at five and enjoyed all." . . . Tony also enclosed the July 26 issue of *Investor's Reader* with a feature article on President **George Trimble** of Bunker Ramo Corp. George was named to head B.R. in 1970 after having served over 30 years with Martin Marietta, B.R.'s biggest stockholder. From 1967-69 he served as deputy director of N.A.S.A.'s Manned Spacecraft Center. Business is looking up for B.R. under George's direction. . . . **Henry McGrath** has sent an announcement of the American Section of the Société de Chimie Industrielle, Inc., of which he is the president.

The Alumni Office has noted the death on June 26, 1972 of **Donald W. Kenny** who was with Rohm and Haas Co. in Philadelphia. No further details are currently available.

Your secretary has relinquished her apartment in Cambridge and can now be reached only at her Connecticut address. The results of the consolidation, after 25 years of maintaining two residences seems to be a superabundance of waxed paper, curry powder, and dry mustard, plus many too many books.—**Alice H. Kimball,** Secretary, P.O. Box 31, West Hartland, Connecticut 06091

37

Our thirty-fifth Reunion at Chatham Bars Inn on Cape Cod was outstanding in all respects with a total attendance of over 80 members of our Class and their wives. The accommodations were excellent and the food the same. The weather was perfect on the Cape and a group of golfers played at Oyster Harbors Club which has one of the finest golf courses as you will remember from our 30th Reunion. The Chatham Bars Inn also had a challenging nine-hole course so that the golf tournament was a two-division affair. At Oyster Harbors, for the men, **Charlie Kahn** won the low gross with **Walt Sherry** taking the low net and **Al Busch** closest to the pin. For the women, the low gross prize went to Maria Busch with the low net to Estelle Kahn, who also was closest to the pin. At Chatham Bars for the men, **Bill Bergen** won the low gross with **Ralph Webster** taking the low net. For the women, the low gross prize went to Pogo Bergen and the low net to Ruth Dreissigacker.

Len Seder had done his usual fine job on the class statistics and presented them on Saturday evening with many humorous remarks. A sampling of the statistics follows: Net worth: top decile $900,000, median $190,000 lower $55,000; Earned income: top decile $70,000, median $25,000, lower $12,000; Principal home value: top decile $90,000, median $50,000, lower $30,000. Sixty-nine per cent of us are Republicans, seven per cent are Democrats and 24 per cent are Independents. For hobbies, golf, photography, yachting, fishing and "other" take the lead; and on ownership of TV, 67 per cent have color sets, 29 black and white and four per cent have none. The large majority believe they owe their success to their straight Course work at M.I.T. and in retrospect the most important thing was the disciplines of learning. Also over 60 per cent believe that most of our young people are great, and that the odd balls are in the minority and are no worse than in our generation.

On Sunday morning, President Phil held a Class meeting at which time the following officers were elected: President, **Philip H. Peters;** Vice President, **G. Richard Young;** Secretary, **Robert H. Thorson;** Assistant Secretary, **Lester M. Klashman;** Treasurer, **Josiah S. Heal;** Class Agent, **John H. Fellouris;** Class Gift Chairman, to be appointed by the President. If you missed your 35th Reunion, we hope you will plan on attending the 40th. . . . **Sidney Sussman** is now located at Olin's Headquarters in Stanford, Conn., as technical director, water treatment department. . . . **Allen Hazeltine,** since May 1970, has been engaged in private practice of patent law in Blue Bell, Pa., near Philadelphia. . . . **Duane Wood** was recently named senior vice president, marketing, by Lockheed Aircraft Corp. . . . **Charles Reed,** Senior Vice President and member of the Corporate Executive Staff of General Electric Co., has received the Carborundum Company's 1972 Award for excellence in chemicals. . . . **James D. McLean** has recently been elected president and chief executive officer of the Information Machines Corp., Santee, Calif. . . . **Sydney B. Karofsky** of Weston, Mass., has been elected president of the Hebrew Rehabilitation Center for Aged, Roslindale, Mass.

It is with regret that I report the death of **Carl Muehlemeyer,** 503 Calvin Park Blvd., Rockford, Ill., on July 20, 1972. An error was made in reporting the address of **Stephen M. MacNeille** who died on March 23, 1972 and whose address had been 3 Granuaile Rd., Southborough, Mass. 01772.

In the future the Class Notes will be written on alternate issues by your secretary, Bob Thorson, and Assistant Secretary Les Klashman. I am sure you will be glad for a change in style. Now would be a good time to drop a line to Les, so that he will have lots to report.—**Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, Mass., 02155; **Lester M. Klashman,** Assistant Secretary, rear 216 Lowell St., Peabody, Mass. 01960

38

I have been in contact with **Paul Black** and our 35th Reunion is moving along under his guidance at full speed. If it is not already on your calendar, mark down June 1 through 3 at Stratton Mountain. This is a new resort, having been built within the last few years, and offers all of the recreational facilities that you can desire. Paul has been up there and tells me, even though he cannot be easily impressed, that it is a great place.

Jack Crichton writes, "have been in petroleum and mining since graduating in Course III. Have my own management and consulting petroleum firm. Am president and director of several independent oil and mining companies, also director of Clark Oil and Refining Company. Spend much time in Saudi Arabia, Alaska, and England. Was Republican Candidate for Governor of Texas—1969."

News is pretty sparse this month. Obviously you have been shirking your duty. If you would like to see more in this monthly write-up, drop me a line.—**A. L. Bruneau, Jr.,** Secretary, Hurdman and Cranstoun, Penney & Co., 140 Broadway, New York, N.Y. 10005

39

This will be a short column, for thirty-niners have been slow this month in supplying news of themselves. How about rectifying that condition next month?

Bill Brewster hit the big-time pages in October, although I'm not sure that he really relished the way that a major *Fortune* article covered his company, "Chairman William S. Brewster insists that the company has come through a 'bad patch' in good shape. But U.S.M. shares are selling below book value, and some investors who have been buying up large blocks of stock are talking about partial liquidation." . . . **Gordon Pope** also appeared in that *Fortune* article, mentioned as part owner in a company in Puerto Rico which he persuaded Brewster's U.S.M. to purchase during an acquisition program.

Classmates living in Massachusetts are doubtless accustomed to hearing about Governor **Francis Sargent's** various political activities, but for those of us who don't live there, Frank has been receiving many plaudits for the no-fault auto insurance program which he helped pioneer, and which is copied—at least in part—by many other states.

This next item was apparently delayed in transit somewhere; nevertheless, heartiest congratulations are still in order: **Robert L. Frank** and a colleague at Sperry received the I.E.E.E. Group on Aerospace and Electronic Systems "1971 Pioneer Award," in recognition of contributions to the development of radio navigation systems. Bob Frank's present position is Senior Research Section Supervisor, Sperry Division of Sperry Rand Corporation, in Great Neck, Long Island, New York. . . . Also at Sperry Rand is **Ben Badenoch,** Vice President, working on new ventures. . . . **Gus Hunicke's** Precision Timer business is going well, according to a note contained in a letter from **George Beesley.** Gus' son Jim is now in the business with him. George himself has formed his own consulting firm, Beesley Associates, Inc., Consultants and Industrial Managers, located in the Statler Office Building, in Boston.—**Oswald Stewart,** Secretary, 3395 Green Meadow Circle, Bethlehem, Pa. 18017

40

Merry Christmas and a healthy and happy New Year to all classmates! . . . **Jim Rumsey,** after long service with duPont, has retired and gone into business for himself and has passed along the following note: "In April 1972 I retired from duPont after 32 years service to establish a management consulting and service company with a colleague, James Monkman, who retired from Hercules. The business is concentrated on international management projects in the plastics, chemicals, fibers and textile industries. We work on acquisitions, divestitures, technology licensing, venture planning and financing, and business strategy; very fulfilling." . . . **Joe Greenberg** is now vice president of A. T. Kearney, Inc., international management and engineering consultants. Joe is a Fellow of the American Society for Metals and prior to joining Kearney was vice president of Boynton Engineers. He will be in charge of Kearney's plant facilities and environmental engineering activities, specializing in the metal working industries.

Amos Joel has been awarded the Leonard G. Abraham Prize Paper Award of the I.E.E.E. . . . **M. Spalding Toon** has been elected president of the Pittsburgh and Conneaut Dock Company in Conneaut, Ohio. . . . Among many classmates who now do work in the field of environmental control, **Russell DeYoung** is serving on the National Industrial Pollution Control Council. . . . **Bob Dorsey** has been elected president of the Illuminating Engineering Society. He is manager of the engineering and education department at G.E.'s Nela Park in Cleveland. . . . As a final note, **Sam Goldblith** is now the Underwood-Prescott Professor of Food Science and deputy department head in the Department of Nutrition and Food Science at Tech.

That is the news in brief; to make it less brief, please write to Al.—**Al Guttag,** Cushman, Darby and Cushman, 1801 K St., N.W., Wash., D.C. 20006

41

Your Class of '41 Secretary is alive and well and still on Nantucket Island, even though there have been no Class Notes for the last two issues. A combination of summer activity and a rich secretary who could afford to take the entire summer off left me to struggle through the busiest season of the year. I'd fire her, but I needed her to type the Class Notes.

Accumulated news includes a note on **Robert L. Wooley** of Scottsdale, Ariz., who for the past two years has been commuting weekly to his job as president of Teledyne Sprague Engineering in Gardena, Calif. I suppose it beats the freeways! . . . Cryogenic Technology, Inc. announces the election of Dr. **Howard O. McMahon** as chairman of C.T.I.'s Board of Directors. Dr. McMahon is one of the pioneers in modern low-temperature technology. He is a member of the American Association for the Advancement of Science, the American Academy of Arts and Sciences, the American Chemical Society, and the American Physical Society. Dr. McMahon has served as president of Arthur D. Little until recently when he assumed his present position as senior vice president on the corporate technical staff of A.D.L. Dr. McMahon was also recently appointed by President Nixon to the President's Committee on the National Medal of Science.

Professor **Stanley Backer,** Head of the Fibers and Plymers Laboratories and Professor of Mechanical Engineering, M.I.T., was granted Honorary Membership in the American Society for Testing and Materials. He received the award "for his emminent qualifications as one of the world's foremost textile engineers." . . . Recently elected to the Corporation of M.I.T. is Dr. **Ralph Landau,** President of Halcon International, Inc., also a member of the M.I.T. Corporation Development Committee, the Corporation Visiting Committee for Chemical Engineering, and the National Sponsoring Committee for Chemical Engineering. Dr. Landau was also recently elected to the National Academy of Engineering that cited his contributions and leadership in development, engineerng and marketing of new chemical processes.

A. W. Welch announced the opening of an engineering office in Manchester, N.H., this May for consulting in the paper and pulp industry. Where does Bill get the time, considering his association with Industrial Design Co., Inc. of Cleveland, Rust in Montreal, Main in Boston, and he still has time to maintain an office in Surrey, England. His commuting schedule must challenge Wooley's. . . . **Austin E. Fisher, Jr.,** returned to Northeastern University last September as a Professor of engineering management in the College of Engineering, after a year of teaching in St. Croix. . . . Even while struggling with computer problems, **Howard Samuels** has built a multi-million dollar industry as head of New York City's off-track betting. One of his bigger problems is the legislation which created O.T.B., threatening the track's attendance, since some of the gamblers prefer a visit to their friendly O.T.B. window than a personal appearance at the track. Maybe Howard's problems will be solved if the prediction of the *New York Times* Sunday Magazine a couple of weeks ago, picturing him in living color on the cover as one of the Mayoral possibilities for New York City, results in his election to that post.

George N. Emmanuel has been named manager of quality control in the nuclear equipment department of the Mt. Vernon, Ind., works of the Babcock and Wilcox Co. . . . **Jerome Namias,** Chief of the Extended Forecast Division, National Meteorological Center, National Weather

In May of this year, the American Society of Mechanical Engineers conferred its "President's Award of Merit" on Dr. Edward E. David, Jr., Sc.D.'50, Director of the Office of Science and Technology. In the photo, Rogers B. Finch, '41, (right) Executive Director and Secretary of A.S.M.E., looks on while A.S.M.E. President Kenneth A. Roe, '41, (left) presents the award to Dr. David.

Service since 1941, has retired. He plans to spend most of his time at Scripps Institute of Oceanography in California and will also be the Rossby Fellow at the Woods Hole Oceanographic Institution in Massachusetts.

Stanley E. Webber has been appointed a vice president of Litton Industries Electron Tube Division, San Carlos, Calif. . . . **Robert Ferguson** died of an unexpected heart attack on January 13, 1972. As a prominent educator in Florida, he has been selected as the Star Teacher in the State of Florida (Physics) and was on the M.I.T. Counselors Staff.

In a recent address delivered to the South Texas Section of the American Society of Mechanical Engineers, **Kenneth A. Roe,** President, encouraged the various engineering societies to develop a program of inter-society cooperation. Unity between the various professional organizations, of traditionally independent discipline, he says, is the best way to deal with the current problems of reemployment and also for the needs of the future. . . . **Jim Cullison,** Colonel, U.S. Army Reserve, was one of 67 Army Reserve Officers selected to attend a National Strategy Seminar at the National War College in Washington, D.C. this June. . . . At the University of California, Charter Day 1972 honored **Albert Bowker** as Berkeley's fifth Chancellor. His remarks traced the growth, challenges, and accomplishments of the University in recent years.

Luke Hayden flew his plane over to the Island in August with Dot as his co-pilot. They were accompanied by their daughter and son-in-law, and Pat and I had a few pleasant hours with them. Makes us wish more of the Class of '41 would find their way to our wonderful Island where the moors are now red with the promise of an early winter. . . . The hiatus from the last two issues has hopefully been covered with this lengthy release, and your Secretary promises to see you in the next issue, if his secretary doesn't decide to spend the winter on the Riviera.—**Michael Driscoll,** Secretary, 23 Broad St., Nantucket, Mass., 02554

42

Our Class was well represented at the Alumni Officers Conference in Cambridge on October 6 and 7 with **Paul Hotte, Lou Rosenblum,** Charlie Speas, **Eric Wormser, George Schwartz** and **Hugh Schwartz** attending. The big news from the A.O.C. is that **Charlie Speas** was awarded the Alumni Association's Bronze Beaver Award with the following citation: "In Grateful Recognition of Distinguished Service to the M.I.T. Alumni Association, the 1972 Bronze Beaver is awarded to Charles A. Speas '42. Honorary Secretary, Educational Council Chairman, M.I.T. Club President and Director, and Alumni Fund worker are only a few of the manifestations of your strong and abiding interest in M.I.T. Your longstanding efforts have had a lasting effect on alumni and students alike in your area, and you have earned the title of Mr. M.I.T. of Baltimore." We congratulate Charlie on the award and are particularly proud that he is the second member of our Class to receive the Bronze Beaver. We reported last year that **Dick Meyer** received this award at that time.

Reece Wengenroth writes that he is busy with his extracurricular activities as a director of the Chicago Engineers Club, secretary of Consulting Engineers Council of Illinois, and a director of the Chicago Engineering and Science Center. . . . **C. B. Smith** has been appointed director of the incentives office of the National Science Foundation. He comes to N.S.F. from his previous position as vice chairman of the research and development study group of the Commission on Government Procurement. . . . This may be an "oldie" but we have received a clipping announcing that **Henry Hill,** President of Riverside Research Laboratories of Haverhill, Mass., received an honorary Sc.D. from Merrimack College last June.

Jon Noyes is organizing a group to attend the M.I.T. of Mexico City Fiesta in Mexico City scheduled for the Spring of 1973. Everyone who has gone to the Mexico City Fiesta has always had a great time. Do get in touch with Jon for particulars. . . . Met **Alan Katzenstein, Adrian Marcuse, Gaza Neumann,** and **Bill Van Nostrand** at the fall meeting of the Board of Governors at the New York Alumni Center. Alan is working hard in his new job as deputy general chairman of the Center and Bill has just been appointed chairman of the placement committee. . . . Really not much "hard" news this month. Let's hear from you—**L. K. Rosett,** Secretary, 191 Albemarle Rd., White Plains, N.Y. 10605

43

My campaign in soliciting personal letters from classmates has produced the second and third letters for calendar year 1972. Hurrah! The first was from **Stan Procter** and the second from our former "varsity Secretary" **Dick Feingold.** In order not to shoot all my material in one column, I hereby elect to publish Feingold's little gem first. So, with due apologies to Stan, who will appear in a future issue, here goes with our ex-Secretary's account of his new life on the West Coast. Dick writes, "It must be fun to be Class Secretary and to receive so many letters from classmates. I envy you. As class treasurer I wish to report a balance of $1,809.53 as of August 21, 1972, safely stashed away in the Mechanics Savings Bank in Hartford, Conn., earning five per cent interest. **Jim Hoey** has informed me that the 30th Reunion committee has reserved a fine resort hotel on Cape Cod for next June. I arrived in Santa Barbara in June, and have been busy preparing for the transferring attorney's exams which I will take in March of 1973. You have done a fine job with the Class Notes. I suppose you know the joke about how you make a secretary a permanent fixture. It happened to me, so why shouldn't it happen to you."

Many thanks Dick for your kind remarks and here's hoping that our mutual friends of 1943 will note your implied invitation that we all circle June 1973 for a 30th Reunion which ought to be a dilly! With Feingold breathing all that beautifully pure Pacific Ocean air at Santa Barbara he might even win the award for "youngest child!" His new address for those who want to know is: 4860 Via Los Santos, Santa Barbara, Calif.

Seasons Greetings to all.—**Jack Kelly,** Secretary, 34 Scudder Rd., Westfield, N.J. 07090

45

Have you returned the Spain coupon that accompanied President **Tom McNamara's** October Class Letter? If not, you still have time to leap aboard the Madrid-Torremolinos band wagon.

Friday night, March 30th, TWA departure to Madrid thence to Malaga where your self-drive car will take you to Torremolinos on the Spanish Riviera. Three days on the sunny coast—golf, tennis, loafing, with the opportunity to spend a day across the Straits in Spanish Morocco. Two or three days in Madrid and then back to the world of reality. The $310 per head price tag includes round trip economy from either Boston or New York, double occupancy at a first class hotel, auto rental (no mileage), two meals per day at Torremolinos, breakfast only in Madrid, two half-day sightseeing tours, transfers, and intercity travel.

University Travel in Cambridge will be handling the promotion and detail of this enjoyable vacation. Your coupon, inquiry, or glimmer of interest should be sent along to Tour Director, **William H. Shuman,** 15 Summer St., Milford, N.H.; Tom McNamara, 41 Summit Ave., Wollaston, Mass., or myself. Friends and neighbors are welcome. Those of you that have discussed the 1967 Bermuda mini-reunion know what a gala affair that turned out to be.

Many may ask why vice president Bill Shuman was chosen tour director. In 1967 Bill arrived at Logan with family but without clothes. With added responsibility, it is hoped he shall remember his clothes in 1973. I might add that your mini-reunion committee of Mr. and Mrs. Tom McNamara, **Bob Maglathlin, Clint Springer, Gerry Quinnan,** and Bill Shuman plus lonesome **Bill Meade** fully enjoyed putting the finishing touches on this trip Saturday, October 14, at the new Dunfey's Tavern in Lexington.

In late September, **David R. Clare,** a director of Johnson and Johnson, was elected chairman of three units—Johnson and Johnson Domestic Operating Co., the newly formed Baby Products Co., and Johnson and Johnson, Ltd. in Great Britain. More than enough for one man to do! Our congratulations, Dave. . . . **Donald J. Lovell** of Stow continues as professor of optics at Mass. College of Optometry; this spring Don will be a visiting professor at Pacific University teaching physical optics as well as a physics course for liberal arts majors. . . . Your Secretary was honored to receive a Bronze Beaver award during the early October Alumni Officers Conference meetings.

Interesting changes of address: **Walt Borden** after 20 plus years in Westfield, N.J. to 205 Oak Ave., Severna Park, Md.; **Jim Critchlow** still with U.S. Information Agency in Washington—or elsewhere!; **Pete Hickey** from Morrestown to 727 Fairmount Ave., Chatham, N.J.—no more 90-minute commute to Newark, now only 65 minutes on Route 22; **Jim Hoaglund** from New York City and Princeton to 5133 Wooddale Ave., Edina, Minn.—the Minneapolis-St. Paul area; lastly, **Bill McKay,** 44 Pond View Dr., Centerville, Mass.

Ho! Ho! Ho! and a Merry Christmas to you all.—**Clinton H. Springer,** Secretary, P.O. Box 288, New Castle, N.H. 03854

47

The class file indicates that there is more information on reunion that should be reported, as well as biographical sketches that will be used as space permits. For the reunion reception at the President's house and luncheon following, through the efforts of **Fred Ehrich,** we invited some of the present professors and administrative staff as well as professors from our days at the Institute. **Claude Brenner** has just sent me this file so will try to excerpt from it to the best of my ability. Some of the names are unfamiliar to me but perhaps you have a much better memory than I. Attending were: President Wiesner, Chancellor Gray, Jim Killian, Howard Johnson, Fred Lehmann, Mrs. Karl Compton, D. P. Severance, Dean Sizer, Walter Rosenblith, Francis Schmitt, Prof. Rogowski, Branden Rightmire, Prof. Meissner, Robert Mann, W. T. Martin, Alfred Keil, J. C. Hunsaker, Lawrence Heidt, L. J. Hamilton, Robley Evans, Stark Draper, Raymond Douglass and Prescott Crout.

Among those sending their regrets were: Professor John Wilbur now living in N.H.; Julius Stratton who was in England; Paul Samuelson; Thomas Sherwood who now resides in California; H. B. Phillips; Charles Myers; Bill Murray; Warren Lewis; George Harrison; Lee Gamble; Harold Freeman; J. Den Hartog; Howard Bartlett, who is now in Maine; Samuel Collins now in Maryland; Vannevar Bush; Doug Brown; George Scatchard now 80 years old; Raymond Bisplinghoff; Harold Edgerton who was in Greece; Francis Hildebrand; C. L. Svenson who is not in the best of health; Deane Lent; Stanley Livingston now living in Santa Fe and consulting part time with the A.E.C. at Los Alamos; and last but certainly not least, Bill Greene who was attending his 50th reunion at Brown.

Ed Kane was unable to attend reunion due to having had major surgery. Sorry to hear this Ed and hope now all is fine. **John Martin** has been appointed executive vice president of Addressograph Multigraph in charge of U.S. operations. . . . **Edwin Lawrence** has left G.E. after 25 years to join Rockwell in Pittsburgh as manager of value control. . . . **Louis Goodman** has been promoted to assistant director for education and training in the East-West Technology and Development Institute in Honolulu. . . . **Robert Peach,** manager of quality assurance for Sears Roebuck, has been re-elected vice president of the American Society for Quality Control. . . . **Mitch Keamy,** General Manager of the Cement and Mining Systems Division of Allis Chalmers, was recently presented the first annual Chairman's Award by D. C. Scott, President and Board Chairman.

Have a pleasant holiday season.—**Dick O'Donnell,** Secretary, 23516 Lincoln Rd., Bay Village, Ohio 44140

48

The class officers meeting in August and the 25th Reunion Committee meeting in September have put our 25th Reunion on the launching pad and the coming months should see completion of preparation for the final count-down on Thursday night, May 31, 1973. Hopefully, there will be enough celebration to keep us in orbit for the weekend.

The plans provide one day of the program to be on-campus activities designed to remind you of the good old days (Oh, God!) when you were a student. Although no details are finalized; presumably, we would want to either meet, hear about, or listen to our professors, including Professors Bartlett, Adams, Irwin, Frank, Liepman, Hildbrand, Sears, Wadsworth, Hill, Brown, Holt, Rogowski, Draper and many others we remember. The program committee has other opportunities on today's M.I.T. campus for this on-campus activity.

Another day will be at a location designed to renew friendships and have a good time with golf, tennis, swimming, and related activities to serve as focal points for gathering of classmates. A bus tour or boat ride are probably going to be included on the third day. Tech Nite at the Pops with Arthur Fiedler is Sunday night. Monday the program and luncheon is organized by the Alumni Homecoming Committee. The reunion committee decided to invite alumni affiliated with classes other than '48. The mixing of classes during 1942 to 1950 created many situations where friends who were students together graduated and affiliated with different classes. If you have friends in another class who would like to join you, please extend the reunion committee's invitation to attend the reunion in June. I know this is going to be the greatest reunion ever, and your friends wouldn't want to miss it.

The reunion committee will enlist the support of class members in over 50 regions of the country to conduct class-oriented activities during the coming winter and spring. The reunion committee is made up of **Sonny Monosson, Ken Brock, Bob Bliss, Leon LaFreniere, Frank Durgin, Dave Finnegan, Marvin Rosenberg, Verity Smith, Dave Vigoda** and yours truly. Volunteers for the reunion committee and the regional committees would be welcomed. The location of your residence is not a factor.

Robert H. Thena has been appointed manager of the fuels and special products division of Mobil Oil Corporation's International Division. Bob has been with Mobil since graduation. Bob and his wife Eileen live in North Plainfield, N.J. . . . **Kenneth Wiberg** is Professor of Chemistry at Yale University. He is the 1973 winner of the American Chemical Society's $2,000 James Flack Norris Award in Physical Organic Chemistry, sponsored by the Northeastern Section, A.C.S. Dr. Wiberg is being recognized for his outstanding work in the field of physical organic chemistry, particularly his studies of chemical bonding and the mechanisms of oxidation. He is the author or coauthor of some 120 papers and six books on a broad spectrum of research; his textbook *Physical Organic Chemistry* (1964) is a standard in that field. . . . **William Moser** is Executive Vice President of Bron-Shoe, which today has a virtual monopoly on the business of bronzing baby's first shoes. Bill was quoted in *Newsweek* when he explained that his company finds most sales come with the first baby.—**S. Martin Billett,** Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

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Writing these notes coincides with the arrival of some crisp autumn air in Boston and quickly follows the Alumni Officers Conference which was held at M.I.T. on Friday/Saturday, October 6/7. **Russ Cox** was Chairman of the Conference and **Jack Barriger** and **Leonard Newton** were on the committee and active as moderators. As usual, the high point of the Conference was the Saturday morning report on "New Teaching and Research Activities." Dr. Rosenblith's description, "dimensions of liveliness on the M.I.T. scene," captures the essence of the morning, as he and six other M.I.T. professors talked about their fascinating work. The experience dramatically renewed my sense of the excitement, vitality, and importance of M.I.T. as an educational and research institution.

Other class members and wives in at-

tendance were **Paul Weamer, Stan Margolin,** Doris and **Archie Harris, George Piness,** Nell and **Fletcher Eaton,** Betty and **Ira Dyer,** and my wife Sonya.

We were all saddened by the terrible tragedy when **Russ Cox**'s fourteen-year-old daughter, Cynthia, was killed in the tornado at Longwood in August. Our hearts go out to Russ and his family in their bereavement.

On a happier note, we have received a birth announcement (in translation from the original French) as follows: "Mr. **Georges Diligenti** and Madame (née Marie Jeanjean) leave to Christine, Barbara and Maria-Pia the joy of announcing to you the birth of their little brother Robert, June 5, 1972." Congratulations!

In connection with the A.O.C., **Len Newton** convened a meeting of the Class 25th-Year Gift Committee, consisting of all those who have been mentioned earlier as attending the Conference. News of plans will be coming to you fairly soon. A brochure is in preparation and we are organizing to collect the money needed to fund a visiting professorship for the Institute. During one of the seminars at the A.O.C. on Friday, Paul Weamer asked what the value of a visiting professorship would be. William Ted Martin, former Chairman of the Faculty, replied that particularly in the coming years, it could be of great value since this is likely to be a period of little growth in staff, and visiting professors can help to provide a needed stimulus and excitement to the Institute community.

Professor **Robert L. Bliss,** Chairman of the Department of Architecture at the University of Utah, was installed as a member of the College of Fellows at the American Institute of Architects in Houston, Texas. Prior to joining the Utah faculty as Department Chairman in 1963, he taught at M.I.T. and also at the University of Minnesota. He is a member of the advisory council representing Utah on the National Trust for Historic Preservation. He has also served as President of the Utah Heritage Foundation, and the Association of Collegiate Schools of Architecture.

Burlington Northern, Inc., the largest railroad in the country in terms of track mileage, has given **Thomas Lamphier,** Vice President, Executive Department, the overall responsibility for a major computer-system development project designed to achieve major cost savings.

Dr. **George N. Hatsopoulos** was the subject of the "Hellenic Profile" during the summer in the *Hellenic Chronicle,* a Boston Anglo-Greek newspaper. His Thermo Electron Corporation is one of the firms on Route 128 that are still alive and well with such diverse product lines and markets as a Rankine Cycle energy unit promising pollution-free automotive propulsion (sponsored by Ford), and an artificial heart now in experimental use in animals. Stockholders have been rewarded with a 500% appreciation since the company went public. Nice going, George. Keep up the good work.

That's all till next month. Write if you get work. **Frank T. Hulswit,** 72 Temple Rd., Concord, Mass., 01742

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W. Leslie Allison has been appointed financial officer for the Chemicals Group of Olin Corporation in Stamford, Conn. He has served in a variety of production, financial and marketing positions with Olin since he joined the company in 1953. Most recently he was general product manager for urethanes.

Dr. **Kerson Huang,** Professor of Physics, has been awarded a Fulbright-Hays grant for the purpose of lecturing in physics at the Latin American School of Physics in Caracas, Venezuela.—**John T. McKenna, Jr.,** 2 Francis Kelley Rd., Bedford, Mass. 01730

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In the June issue I reported the death of **Bill Carmack.** The following details were received subsequently. Bill was working for Fisher Controls Co., a subsidiary of Monsanto as market develop manager for electronic instrumentation. He was on temporary assignment in Cornwall, England where he died of a coronary thrombosis while out shooting with friends. He was survived by his wife, Barbara, and by two children from a previous marriage.

I'm still reporting news received at the 20th Reunion so I apologize if the following is out of date. **George Underwood** is engineering and marketing manager for Cornell Dubilier Electronics in Raleigh, N.C. He's been active in the National Association of Relay Manufacturers; raises poodles for show; and has three children ranging from 12 to 18. . . . **Glenn Mackey** is a Colonel with the Air Force. His most recent assignment was at Headquarters, Air Force Logistics Command in Dayton. . . . Another '51er at The Architect Collaborative at Cambridge is **Qazi B. Ahmed.** He was project architect for Tufts New England Medical Center and for the Maine Medical Center. The Ahmeds have two children, ages 6 and 2. . . . **Bob Lindquist** reports that he is branch manager for Atlantic Bearings and Drives, Inc. in Cape Elizabeth, Maine.

In response to the question, "Anything else that we can report in the *Review*?", **J. Harry Wolf** says, "Life is great!" Harry is in the New York office of Arabian American Oil Co., managing their U.S. data processing. This involves a New York to Arabia computer-communications system for oil cargo production and planning. . . . **Bertram E. Eakin** received a doctorate from M.I.T. in '62; is now director of research for P.V.T., Inc. which is a thermodynamics and physical properties lab doing contract measurements for the oil, gas and chemical industries. Location: Houston.

With I.B.M. since 1951, **George Collins** specializes in systems evaluation (time sharing, special purpose entrance data, etc.) with emphasis on man-machine interphase. The Collins family, including two teen-age boys, were trying to purchase a barn with the plan of remodeling it into their "dream house."

Philip Gray writes that he is program manager for American Science and Engineering, a firm located in Cambridge. . . . With Polaroid Corp., **John Pasieka** is manager of industrial products engineering. During off-hours he is chairman of the Acton Planning Board. . . . **Sidney Dressler** is product manager of vacuum furnaces for Sunbeam Equipment Corp., Meadville, Pa. The firm manufactures industrial heat treating furnaces. . . . Father of four girls, ages 6 to 14, **George L. Boyden, Jr.,** is president of E. E. Specialists, Inc.; Assembly Specialists, Inc. as well as "lesser affiliations." E.E.S. is a manufacturers' representative; A.S.I. specializes in wire wrapping and other manufacturing services (wire tapping too?) Living in Boxborough, Mass., George has almost as many outside interests as he does companies, including a connoisseur's fruit orchard, Actor's Lyric Theater, membership in the New York State Fruit Testing Cooperative Association, as well as performing as a professional bass soloist.

Some of us are still going to school. **Chris Rust** received an M.B.A. from the American University in May of '71 and **Robert Hudders** earned the same degree from the State University of New York at Buffalo a year earlier. Bob is with Union Carbide Corp., Linde Division, where he has been involved in cryogenic food freezing and mechanical design of distillation trays. He and wife, Shirley, have two young boys, 5 and 3. . . . **Doug Jones** notes that he is president of L. E. Jones Co., but doesn't describe the type of business. Living in Menominee, Mich., Doug is active in sailing and skiing. . . . At least one member of the Class ran for the U.S. Senate. **Peter J. Booras** tried for the Republican nomination in New Hampshire but lost to former governor Wesley Powell. Booras, a resident of Keene, got interested in politics earlier in the year when he launched a drive to gain write-in votes for Spiro Agnew for the Vice Presidential nomination during the presidential preference primary. His business activities include Yankee Artists, a greeting card firm which he began after designing his own Christmas card one year, and Verily Development which does research work in food machinery. . . . Also in politics, **Harold Siegel** has been active in campaigning for Congressman Larry Hogan of Md. Hal is a lawyer in Greenbelt, Md., specializing in government contract disputes. He and wife, Consuelo, have six children from 8 to 15, but Hal still has time for hobbies, namely, (1) keeping up with his wife, and (2) driftwood collecting.—**Fred W. Weitz,** Secretary, 4800 S.W. 74th St., Des Moines, Iowa 50321; **Marshall Alper,** Assistant Secretary, 1130 Coronet Ave., Pasadena, Cal. 91107; **John Dowds,** 1800 N.W. 18th, Oklahoma City, Okla. 73106; **Samuel Rubinovitz,** Assistant Secretary, 3 Bowser Rd., Lexington, Mass. 02173

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Here it is, fall again. With the summer over, drop us a note on your activities.

We have learned that **Dave Chorlian** is New Products Coordinator at T. J. Lipton Inc., where Dave has been for almost 15 years. He has a lovely wife Thelma, a Julliard graduate, who is director of music at their church, Christ Lutheran, in Woodcliff Lake, N.J. Dave, who was concert master in the M.I.T. Symphony, plans to join the Ridgewood Symphony in the fall. The Chorlians have two precious adopted children; Wendy, 10 and Philip, 6. . . . **Arthur Jacob** lives in nearby Hackensack and **Jack Gradijan** in Rivervale. Sounds like they could have a small reunion on their own.

Dean Jacoby and **Dave Springsteen** got together at the Institute when Dave was there to discuss nuclear engineering with the M.I.T. staff. Dave has left Chase Manhattan and is now with Stone and Webster Securities Inc. with a major interest in the utility industry. Though based in New York, Dave is still sailing but seems to have more interest in cruising than in racing in recent years. . . . **Paul Spreiregen** has recently published his fourth book on the subject of a new town in Finland, Tapiola. The book was co-authored with Mr. Heikki von Hertzen, builder of the town. *Building a New Town: The Story of Finland's New Garden City, Tapiola* will be published by M.I.T. Press. At last look, Paul lived in Washington D.C. Other '54ers located near Paul include Dr. **Henry Myers, Richard Lane, George Lamphere, John Smith,** Major **Fred Hofmann,** and the Rev. **Raymond Schaub.** . . . **Roy Kaplow** has been promoted to a full professorship at the School of Engineering. Our congratulations to a fine educator. . . . **Bill McTigue** has left the Institute and, as vice president of Haley and Aldrich Inc. has received an award certificate from the chairman of the C.E.C.N.E. awards committee relating to the interstate 95 interchange program.

Our column would not be complete without mention of our illustrous classmate, Dr. **Paul E. Gray,** Chancellor of M.I.T. Paul was recently elected to the Board of Trustees of Boston's Museum of Science. His fertile mind should prove a real asset in their drive for an expanded program.

Drop a line to us or drop in on us. If you get within 50 miles of Boston and don't make contact, we will feel hurt. With this issue, we would like to start two new features. Can anyone tell us of our unknown classmate of the month, last known as **Robert W. Reichard**? Conversely, we know that **Bob Evans** has left the country. What's your guess as to where Bob is? Look for us next month—**E. David Howes,** Box 68, Carlisle, Mass. 10741 or **Charles Masison,** 76 Spellman Rd., Westwood, Mass. 02090

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Winter brings us our share of darkness and cold, but I hope you find enough warmth to cheer you through the season. . . . **Joseph Clumpner** sends his greetings from Beirut, Lebanon, where the summer weather has been beautiful. He has been teaching physics to first and second year engineering students, and this year he is introducing some chemical engineering courses. . . . **D. J. "Pete" Peterson** is a vice president at First National City Bank, in charge of computer services. He has been in New York City since May 1970, after leaving Ford Motor Co. He reports that his daughter and two teen-age sons keep him hopping. . . . **Gary Brooks,** Vice President of marketing for Scott Graphics, Inc., recently announced the use of metric measurements for the firm's product line.

Sheldon N. Busansky has been appointed a trustee of the Lowell Technological Institute by Governor Sargent. . . . Advanced Metals Research Corp. has promoted **Sheldon H. Moll** to the position of vice president of marketing. He most recently held the positions of laboratory director and vice president of development. Dr. Moll is also a member of the board of directors of A.M.R. He and his wife Gloria have six children.

Colonel **Leonard R. Sugerman** has won the 1971 Norman P. Hays Award for outstanding achievements in the field of navigation. Presentation of the bronze plaque was made at West Point by the president of the Institute of Navigation. Colonel Sugerman is the chief of the Air Force Special Weapons Center's Plans and Requirements Office at Kirtland A.F.B., New Mexico.

A somber closing note is that **Roy Salzman** was injured at home in an accident with a power saw. He is recovered, and continues to serve as director of information services for Arthur D. Little.—**Allan C. Schell,** Secretary, 19 Wedgemere Ave., Winchester, Mass.

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How proud we were when **Walter Frey** was awarded a Bronze Beaver at the October Alumni Officers Conference. This is the highest honor that can be given to any graduate, and Walt was the youngest recipient this year. Given with the Bronze Beaver statue was testimonial written especially for Walt stating, "Your diligent and industrious leadership as an Education Counsellor, Alumni Fund worker and committee member, and chairman for Alumni Activities in the New York area has been a positive and moving force in the conduct of M.I.T. alumni activities. But, most of all, your constant and forceful interest in these activities has been an inspiration to your associates." In addition to the Bronze Beaver, Walt also was presented a 1972 Presidential Citation as a member of the Long Island Educational Council. This citation recognized the years of alumni contact with schools and students that ". . . has resulted in an exceptional pool of talented young people who annually are admitted to M.I.T. from Long Island." Walt entered Tech from Poly Prep C.D.S., Brooklyn, N.Y. He graduated in aeronautical engineering, and he is now assistant to the vice president and chief of project engineering on new aircraft for Pan American World Airways. In September, he and Beryl celebrated their sixteenth wedding anniversary. Beryl, daughter 14, and son 11, were among the many people applauding the only person to be given two honors this year. Walt came to our fifteenth reunion from his summer house on Martha's Vineyard.

Ted Korelitz, who recently received an M.S. in chemical engineering at Northeastern, reports seeing the following at Boston Latin's twentieth reunion: **Garry Quinn,** who is working for the government in Washington, D.C., and **Harold McKittrick,** who has been with the Perini Co. in Framingham for the last 12 years. Harold is chief structural engineer, specializing in deep foundation work and construction support structures. . . . **John Brazukas** flew in from his home in Puerto Rico. . . . Also present was **Robert McGillicuddy,** who is chief project engineer with Anderson-Nichols, engineering consultants to the construction industry. At home in Winchester, Bob keeps busy with five children, ages one to nine!

Harold Rothstein operates a technical and professional personnel agency in San Francisco. He now makes his home in Burlingame. . . . **Irwin Gross,** Ann, and children have left their earthquake rocked home in California for his home town, Chicago. Irwin has been promoted to assistant regional manager, midwest, Construction Products Division of W. R. Grace. . . . **Karl Pearsons** called from Los Angeles where he is manager of psychoacoustics for Bolt, Beranek and Newman. He has been with this company, which does consulting in acoustics, since graduation. Karl's specialty is subjective testing of people's reaction to noise, such as the loudest or most annoying. Last spring he took the two oldest (8 and 10) of his four sons on a 45 mile, 5-day hike through the High Sierras. He also reports seeing **Richard Teper** who works for Rocketdyne.—**Bruce B. Bredehoft,** P.O. Box 181, Dover, Ma. 02030; **Mrs. Lloyd Gilson,** 35 Partridge Rd., Lexington, Ma. 02173

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Many items this month. . . . **Bill Griffin** is now Associate Director of Laser Engineering in the laser system department at Northrop. . . . From **Don Norman's** wife, Marty, the following note: "Don's third book has finally been published. Its an elementary psychology text to put new life in elementary psychology. I've made the complete switchover. I'm now selling real estate in the La Jolla-San Diego area. We're planning a trip to Japan and Hawaii in August so couldn't make it to the reunion this time. Maybe next time." . . . **Henry Eder** dropped us a card to bring us up to date on his activity. Henry and his wife, Elena, have two boys, 8 and 6. Henry is executive director of C.V.C., a public agency for development that deals with power, water rights, flood control, and environmental protection.

Ron Enstrom, in a recent letter, communicated to us: "After receiving my Sc.D. in Metallurgy in 1963, I came to R.C.A. Labs in Princeton, N.J. My initial research was in super-conductivity, but for the last six years I have been preparing III-IV compound crystals by vapor growth for various device applications.

Daly and I have two children, a boy, 7 and girl, 4. After seven years of volunteer work, Daly started teaching at Douglass College. We very much enjoy the rural setting here with its rolling hills, but also appreciate being close to New York City and participating in the M.I.T. Club social affairs there."

Jay Schumecker writes: "I am still at the Jet Propulsion Lab in Pasadena where I am manager of the project development section, the main activity of which is the designing and building of planetary spacecraft structures. Last summer I took Nancy and the three children on a four month's camping vacation in Europe. I recommend it to all. . . . **Castle Day** is now Executive Vice President with the McCall Pattern Company, and living in New Canaan, Conn. . . . Also now in Connecticut is **John Marsla.** With Carol and the four children, John relocated from South Bend, Ind. to Woodbury. John is still with Uniroyal and now is product manager for Royalene EPD synthetic rubber. . . . **Sam Links** has organized a new enterprise and would like to hear from classmates with experience in the data processing area—i.e. data terminals, data transmission, software, and turn-key systems. The address I have for Sam is 30 Ward Road, Sudbury, Mass. 01776. . . . That's all for now. More in 30 days.—**Frederick L. Morefield,** Secretary, c/o Mobil Oil Caribe Inc., P.O. Box X, Caparra Heights Station, San Juan, Puerto Rico 00922

58

Our peripatetic reunion chairman, **Gary Fallick,** is indeed everywhere. Thought surely that I could enjoy a dinner at Legal Seafoods in Cambridge, but no—there was Gary, smiling over his squid and recruiting committee members. Hoping to elude him, I went to a Chinese restaurant the next week. This time he was not anywhere in sight but my fortune cookie read "You will have a pleasant vacation and reunion at Harborview on Martha's Vineyard in June." With the snow beginning to fly, the prospect of the reunion in Edgartown looks most appealing.

Ed Newton writes, "I wound up a hectic two years by receiving an M.B.A. from the University of Rochester this past June. I was also appointed manager of advanced products at the Gleason Works. However, all this did not prevent us from having our first boy, James Edwin, bringing our family to three children. Looking forward to our 15th reunion next year." . . . **Edward Crowell** is an Assistant Professor of Medicine at the University of Wisconsin. Recently he received a grant from the American Cancer Society to study problems of blood coagulation in patients. . . . **Robert Parente** has been promoted to a position in charge of real-time computer monitoring and dispatch systems for the electric power industry at Systems Development Corporation.

In the legal world, **Hillel Auerbach** is a principal in the newly formed professional corporation of Winnick, Resnick, Skolnick and Auerbach. . . . **Richard Nyder** has accepted a new job as a systems sales engineer for E.T.L. Research Labs in Oakland. Dick, his wife and their two young children, have moved to a new home in the Oakland area. . . . A wry note from **Albert Wray:** "I am teaching math by day, playing music at nights and summers, and restoring old cars, all in lieu of marriage." . . . For those planning an extended sojourn in Israel, a note of caution from **Alfred Neuberger.** "In November 1969 we went to Israel where I worked in one of the government laboratories. After a two-year stay we decided to return to the U.S. I would be glad to talk to anyone contemplating a similar move as I could help them avoid many of the potential problems which can be experienced there. Am now working at MITRE and living in Winchester, Mass. If anyone would like to get in touch about it."—**Michael E. Brose,** Secretary, 30 Dartmouth Street, Boston, Mass. 02116

59

Welcome back! This month we'll start right at the top—our illustrious class president, **Al Bufferd,** has returned to the Institute in the capacity of Associate Director of the Alumni Fund where his assignment will include coordinator of Fund programs for the 20 youngest classes (1959 included!), the Graduate School, and general administration for telethons. Al has enthusiastically thrown himself into his new position and looks forward to renewing acquaintances with many of you '59ers.

Jim Conklin writes that he and his wife have only just recently recovered from their 80-day jaunt up and down Europe in a V.W. campmobile during the summer of 1971 with Anne, 2½ and Dave, 4½. The trip included many European campsites (which they recommend wholeheartedly), a summer school in Sweden and Norway, a conference in France, and lots of professional and personal visits in-between. . . . At a recent American Chemical Society meeting, **John Brauman** was awarded the 1973 Award in Pure Chemistry sponsored by the Alpha Chi Sigma fraternity. John received his Ph.D. in 1963 at the University of California, Berkeley, after which he joined the Stanford University faculty as an assistant professor. He advanced to associate professor in 1963 and full professor in 1972. The award, which John will receive next April during the Society's meeting in Dallas, was established in 1931 "to recognize and encourage fundamental research in pure chemistry carried out in North America by young men and women." . . . **Harrison Morse** reports that he is living in Vermont with his wife Judy and year-old Todd. The past two winters he ran *Sugar A.P.S.A.* taxi company (his own) in Sugarbush Valley. He writes that **Dennis Ward** spent last winter driving taxis with him and that Dennis is currently commuting to Boston for work.

Larry Roberts informs us that he is still in Washington, after five years in the Advanced Research Projects Agency, and is now serving in the capacity of Director, Information Processing Research. . . . Well, it's been a lean month and that's all the news I have for now. With a telethon scheduled for next week, I hope I'll have more news for next month's column. See you then.—**Arthur J. Collias,** Secretary, 61 Highland Rd., Brookline, Mass. 02146

60

This is my first guest column as the Class Vice President for the West Coast. We established the offices of Regional Vice Presidents at the class reunion in 1970 to focus on alumni in particular areas. Linda has gathered up all the news that you sent her, so I'll try to fit it all in without taking up the whole issue of *Technology Review.*

We received a long letter from Mimi and **Dick Kaplan.** Dick is now an Associate Professor of Aerospace Engineering at U.S.C. He has been doing research on the problems of jet noise abatement and has been the director of the Systems Simulation Laboratory. He is now in France on a Guggenheim Fellowship at the University of Aix-Marseilles, conducting computer-aided experiments in turbulence. Dick, Mimi, and their two children were very excited about this opportunity to live in France.

Lots of other members of the Class have chosen academic careers too: **Jon Claerbout** was recently promoted to Associate Professor of Geophysics at Stanford. He and his wife Diane have two sons—Martin and Andrew. . . . **Dick Higgins** is a Professor of Physics at the University of Oregon. He just returned from a three-month visit to West Pakistan, where he served as Visiting Professor at the University of Islambad . . . **Dave Powell** is an Assistant Professor at Stanford in the Aeronautics and Astronautics Department. . . . **Tom Cover** is on a sabbatical leave from Stanford and is now a Visiting Associate Professor in Electrical Engineering at M.I.T. . . . **Bob Wolf** is an Associate Professor of Physics at Harvey Mudd College, Claremont, Calif. In 1970-71, he was on a sabbatical at University College, Oxford, reading philosophy of science.

Morris Selame is a research manager at Monsanto, in charge of fundamental research in high polymer properties and performance. He and his wife Marge spent a couple of weeks in Mexico City recently, which he describes as "Fabulous—all go!" . . . **Juan Llaguno Farias** is the finance manager of Nylon de Mexico in Monterrey. He and his wife have four children. . . . **Bob White** is working at the Xerox research center in Palo Alto. He, his wife Sara, and their daughter Victoria, have just returned from a year's fellowship in Cambridge, England, where he worked with Professor Sir Nevill Mott. . . . **Bob Mapes** is a corporate staff assistant with Avery Products in San Marino, Calif. . . . **Larry Martin** is a program manager for the data services and analysis program at the K.M.S. Technology Center in San Bernadino. He and his wife Marian, have one son.

We visited with Carland and **Bill Nicholson** and their children, Courtney and Brian, in San Francisco recently. He

is now working at the corporate offices of Potlach Forests. He is enjoying the life there tremendously, particularly the relaxed trip to work on the ferry from Sausalito. . . . We also visited with Jan and **Larry Carr.** He is working at the U.S. Army Flight Technology Laboratories at Moffett Field. They and their son David are thoroughly enjoying California, like many of us transplanted easterners. . . . **Bob Slusser** is working for Northrop, handling the financial aspects of their new tactical fighter, the P-530 Cobra, which will have many of its components produced overseas. . . . **Harold Levy** spent a lot of time in Mexico City as program manager in charge of the installation of an automated multiphasic health testing system in a new medical center for Searle Medidata. . . . **John H. Smith, Jr.,** spent his fourth year of medical school at Harbor General Hospital in Southern California. After three years in Philadelphia, he really enjoyed it there.

As for myself, I have continued to be very busy and, happily, still employed at Boeing, doing basic research and development on commercial V/S.T.O.L. airplanes. Charlene and I have two sons, David and Matthew, who was born in April and is keeping us busy. I am the president of the M.I.T. Club of Puget Sound and am fighting the battle to get our super-busy alumni out to club meetings. I hope that anybody visiting Seattle will drop in to see us. We enjoy living here and like to show off the area to visitors.—**Bill Eldridge,** 19604 9th Place S., Federal Way, Wash. 98002

61

Quite a bit of mail has come in with the start of a new school year. The most remarkable letter I have gotten in a long time is from **Peter Gaposhkin** who says that "I obtained a Ph.D. degree in theoretical physics (general relativity) from the University of California, Berkeley. I am now employed as a Mail Handler in Oakland California Post Office while looking for better employment." . . . **Charles Nehf** may have the solution to all this. He wrote that he gave up the engineering "rat-race to be a dirt farmer and raise beef cattle in the hills of southeastern Pennsylvania." The letter's post mark was Kempton, Pa. . . . Another classmate who typifies the strange doings in science these days is **Ken Blanchard.** He got a Ph.D. in chemistry from Princeton in 1967 and then taught at Vassar for three years. Now he writes that he "decided to switch to Medicine. I graduated from Cornell Medical College in 1972 and am now in internship at New York Hospital."

From all that I hear in the halls of Brandeis, these three guys, in their own way, are typical of the state of science and engineering for people of our age these days. . . . **Bill Feldman** has another problem. He writes "I am considering moving to a Brazilian jungle if necessary to escape from the M.I.T. mailing list." . . . **Richard Stifler** is a resident in psychiatry at Mass. General while **Tom Lawford** is chief-resident in internal medicine at D.C. General in Washington. Tom writes that "I am still single and lavishing my affection on a '57 T-Bird. I'm also taking flying lessons. I plan to find a job somewhere in the Virginia area when I finally have to start working for a living."

That's it from the medical profession this month. Grady Harris sent me a letter from **Joe Martins** dated May '71 with a letterhead from Warrane College at the University of New South Wales, Australia. Joe writes "The college, where I took up my post as Master last year, has at present 160 students, and soon will be close to 200. (A 'college' is the equivalent of a 'house' at Harvard). Besides providing accommodations, meals, etc., the college offers a residential environment conducive to intellectual and personal development. I came here toward the end of 1969 having finished my Ph.D. at Harvard in '67." . . . **Grady Harris** also wrote in to say that he "enjoyed home ownership this summer after returning from a vacation in Florida during the month of May. I am anticipating much sailing in the summer months and a second child, hopefully a daughter this time, in September" (no word yet).

Jim Keller is the Chairman of the Department of Philosophy at Wofford College in Spartanburg, S.C., and has been since last June first. . . . Also on the academic scene, **Dick Naylor** writes that "I'm still an Associate Faculty Resident in Burton House. After a year living in Burton-in-exile across the river, it's great to be back on campus—and the building is like nothing we ever had when I lived there as an undergraduate." . . . **Joel Gladstone** wrote from Hampstead, England saying "I have been involved in the development of an interdisciplinary degree, to be called Society and Technology, combining science, social science and quantitative methods in roughly equal measure along with an interdisciplinary (project oriented) laboratory, and a philosophy of science component." . . . **John Ritter** wrote that he is off on a year's leave of absence from the University of Mass. and is working at the Owens-Illinois Development Center. He says that he enjoys industry very much. . . . Other industrialists include **Robert Brown,** who writes "I am living in Wichita, Kan., and am currently a senior engineer for the Litwin Corp. My wife, Faye, and I have two sons—Greg, 3 and Doug, 11 months."

Another engineer, **Laurence Broniwitz** writes in the third person: "Dr. L. E. Broniwitz is currently head of the design of the tracking loops for the F-15 Radar currently being built by the Hughes Aircraft Co., Culver City, Calif., for the Air Force's new F-15 advanced tactical aircraft." . . . More industry: **Gordon Baty** is still president of Icon Corporation in Cambridge, Mass., a company started by Gordon and Don Kennedy. The two of them build numerical controls for industrial automation. Gordon writes that in his spare time he is teaching a course in entrepreneurship over at Northeastern University in Boston. . . .Still more industry: **Robert Mroczkowski** says "I am now in the metallurgy group of the research division of A.M.P. Inc., and live in the Harrisburg, Pa. area. My family is growing chronologically but not numerically."

Manuel Moreno is in his fourth year in Japan, working on a new joint-venture company with Japanese partners and Cooper-Bessemer. **Charter Harrison** wrote that "I have recently joined Merrill Lynch and am now training to be an account executive in the main Seattle Office. I received an M.B.A. degree from Seattle University.

Finally, and a bit exotic, is the note from Professor **Donald G. Morrison** who says he is still at the University of Ibadan, in Nigeria, as director of its computing center. Last summer, Don went to Canada to do some teaching and was able to go around the world in the process. Now he's back at Ibadan for another year before returning to Canada.

Merry Christmas, Happy New Year and Hanukkah to you all.—**Andrew Braun,** Secretary, 464 Heath St., Chestnut Hill, Mass. 02167

63

James Hallock's wife, Georgie, sent in a pleasant note in which she reports a visit they received from **Dale Meyer** and John Merriwether '64. "What was truly remarkable about the visit was that they had flown from Washington in a small private plane. 'Captain John' at the wheel and 'Hawkeye Meyer' doing the visual coordination for the navigation. From listening to their comments it was obvious that they flew either via Rio or Vancouver. (They were unsure.)" In any case the weekend was enjoyed.

Mike Sheriff and wife Sylvia along with children, Andy and Nora, are enjoying Houston since their move from Tulsa. Mike is involved in Legal work at Humble Oil and Refining. . . . **Alan Kamin** reports his marriage to Carol Simon of Boston. He is practicing law in Phoenix while Carol works on her Ph.D. at Arizona State. . . . **Lawrence Kazanowski** is involved in the management of import car planning for the Ford Motor Company in Dearborn. He has returned from 16 months in Turin, Italy where he worked in a similar position with De Tomaso Automobili. . . . **David Caldwell** is working on the system engineering of electronic toll switching at Bell Laboratories in Holmdel, N.J. He has had various involvments with the M.I.T. Electrical Engineering Ph.D. program and the Army Signal Corps as a Captain in Viet Nam.

Kenneth Klein is working on exhaust-system analysis on the F14 program and says that he is still single with no plans for change. . . . **Harry Kaplowitz** writes "that he is busier than ever with Davis's new sister, Allison. Infodata Systems, of which I am a founder and Director, moves into our fourth year—just completed our first acquisition." . . . **Gene Sprouse** has been an Assistant Professor of Physics at Stonybrook . . . **Stephen Gorad** sent in the following, "I received a Ph.D. in clinical psychology from Boston University, and I am taking a long-deserved vacation in the Orient." Steve directs a program on family therapy at Boston State Hospital and has a private practice as well. . . . **H. Robert Lan-**

chester wrote that he was for the moment directing and acting at Florida's State Theater. . . . **Michael Platt** has established his own marketing, consulting, and new-product development company. They are also involved in venture capital work . . . **Gerald Shapiro's** wife writes, "We're very impressed with *Technology Reviews* discussion of urban problems. They were discussed six years ago in sociology class at B.U. You see that we are still talking about the problems—the answers are more difficult to find. No wonder people drop out of society to form their own intimate communities. Most of all, as an unscientific wife of a science M.I.T. graduate, I can at least understand something of your publication!" . . . **Patricia Selby Marzilli** relates that she and husband Luigi are living in Baltimore with their son Alan. Luigi is a professor at Johns Hopkins and Pat is working part time for a retired sulphur chemist who is still writing at age 99!

John Wasserlein is involved with the management of the Boise Cascade Corp., Specialty Paperboard Division. He was attending the Harvard Business School P.M.D. course. . . . **David Claypool** graduated with a M.S. in management from Case Western Reserve University . . . **John Lynch** is at Lincoln Labs after three years at Stanford which he describes as a combination of playing tennis and working toward a Ph.D. in electrical engineering. John is married (wife Mary) and has a son. . . . **Jim Evans** completed his Ph.D. at Tech and is working on air traffic control at Lincoln Labs. . . . **Don Yansen** is working on physical optics at Technical Operations in Burlington, Mass., and lives in Lexington with wife and daughter. . . . **James Queenan** received a master's in E.E. from Northeastern and is working at Sanders Associates in their Ocean Systems Division. He is married and has one son. . . . Also at Sanders is **Gregory Staradub,** who received a master's from Lowell Tech. He is living in Mount Vernon, N.H., with wife Cindy and children, Valerie and Randy. . . .**Calvin Yee** wrote to bring us up to date. He received a M.S. from N.Y.U. in 1965 and was married in 1966. Emma is a graduate of Smith, (Class of 1966). Calvin is with the firm of Drake, Sheahan, Stewart, and Dougall where he works on marketing and physical distribution systems problems. They report a daughter, Wendy Mei and another child was expected.—**Martin H. Schrage,** Secretary, 55 Brackett Place, Marblehead, Mass. 01945

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The Class Hero of the month is **Dave Sullivan,** who wrote to fill me in on his whereabouts over the last eight years. Dave and his wife Maggi are living in a new house in Fairfax, Va., with their two children, ages 3 and 1. After four years with R.C.A., Dave founded C3, Inc., a small company specializing in the design, development, and marketing of mini-computer products. He is now general manager of the firm, and spends his spare time playing hockey and softball. His main impetus for writing was a broken TV set, which, he notes "as an M.I.T. E.E. I am of course unable to fix!" Any more broken TV sets that result in letters to your class Secretary will be greatly appreciated.

John Brownell is with the Los Alamos Scientific Laboratory working in the physics division. He received his Ph.D. from Stanford and had previously been with the Institute for Atoms and Molecular Physics in Amsterdam. He and his wife Sandra have one son. . . . **Dick Carpenter** has been appointed executive director of the Environmental Studies Board of the National Academy of Sciences. Dick joined the Library of Congress staff in 1964 as senior specialist in the Science Policy Research group, and has been chief of the Environmental Policy Division since its founding in 1969. . . . **Robert Clements,** still single, has left Digital Equipment Corp. after seven and one-half years and is now with Bolt, Beranek & Newman in Cambridge. . . . **Bruce Chrisman** graduated from Harvard Business School this past June and is now with Epsilon Data Management in Waltham.

Robert Colvin is now at the Walter Reed Army Institute of Research after completing his residency in pathology at Massachusetts General Hospital. He and his wife Gay have a one year old girl. . . . **Pat Gage** and his wife Nancy live in New Jersey, where Pat is at the Roche Institute doing molecular gene research. . . . **Alan Gamse** has moved into a large circa 1857 townhouse in Baltimore with 13½ foot ceilings. Alan and his wife Barbara have two children, 4 and 1. . . . **Marvin Geller** is an Assistant Professor of electrical engineering and meteorology at the University of Illinois. He is married and has a three-year-old daughter. . . . **Michael Godfrey** is a visiting Assistant Professor in the Department of Civil Engineering at M.I.T. . . . **Michael Hale** is manager of the marketing research division of Human Factors Research in Los Angeles. His second child was born earlier this year. . . . **Sanford Hellman** also reports the birth of a second child this year (it must be catching!). . . . **Jack Prosek** is an estimating engineer for Turner Construction Co. in Chicago. Jack received his M.B.A. from Loyola this past June and is a registered professional engineer in Illinois. . . . **Ron Randall** married the former Sally Kay Einhorn of Washington, D.C. this past May, and honeymooned in Mexico. He is now consulting with the City of New York on the design of a massive computer system to automate clerical operations in the welfare and medicaid programs.

Donald Shapero and his wife Diana are in Washington, D.C., where Don is an Assistant Professor of physics at American University. . . . **Donald Topkis** is at the University of Tel Aviv teaching operations research in the department of statistics. . . . **Edward Wolcott** is in Denver with the energy products subsidiary of Gates Rubber Co., where he is working on a rechargeable lead acid battery. . . . That's the news for now. Best wishes for a happy holiday season —**Ron Gilman,** Secretary, 5209 Peg Lane, Memphis, Tenn. 38117

65

Joe Dyro writes that he has received his Ph.D. from the University of Pennsylvania for work in the Biomedical Engineering Department. Joe's thesis title was "Ultrasonic Study of Material Related to Arteriosclerotic Plaque—Dynamic Viscoelastic Properties of Cholesteric Esters" (whew). Joe and wife Betsy took a few weeks off last Christmas to visit friends in Scotland, Belgium, and the Netherlands. They enjoyed that trip so much that they went back to Europe for a month in September. They spent a week with friends sailing in Ossacher Sea in Austria, and hiking on Alpine trails. They then went to Yugoslavia, Italy, and Germany, and dashed back to the United States where Joe gave a paper at the annual Conference on Engineering in Medicine and Biology at Miami Beach. Last July, Joe, Betsy, and Joe's sister Frances ('63) drove to Nova Scotia for a view of the total eclipse of the sun. The weather was good and they got lots of pictures.

Randy Gabel received his Ph.D. in math from Brandeis last February and is now an assistant professor of mathematics at Purdue . . . And **Charles Seniawski,** a Captain in the Air Force, has entered the Air Force Institute of Technology to study for a master's degree in logistics management. Charles and his wife Susan will be in Dayton, Ohio for the duration of the graduate program.

Fred Gander, a staff economist for the Associated Industries of Massachusetts, has been appointed to the Labor Department's Committee on Manpower and Employment. The Committee evaluates programs of the Bureau of Labor Statistics. Fred and Carol Anne live in Norwell, Mass. . . . **Ed Hoffer** is a fellow at Massachusetts General Hospital in Boston and reports that it is getting harder to leave. Ed has published a couple of articles on computer applications in medicine. Ed spent a month this summer on Martha's Vineyard, combining vacation with work in the Martha's Vineyard Hospital Emergency Room . . . **Steve Loutrel** still teaches Mechanical Engineering at M.I.T. Steve spent two weeks last summer in the Wind River Range in Wyoming and climbed several peaks, including Gannet.

While in Washington this September I dropped in on Susie and **Dave Moran.** They have a nice new home in Silver Spring, Md. and are in the process of getting settled. Dave is still at the Navy Ship Research and Development Center. Susie takes care of the youngsters, but finds time for such things as teaching an exercise class to grade school kids.

That's it for December. I'm hoping for more to say come the new year.—**Steve Lipner,** Secretary, 3703 Stearns Hill Rd., Waltham, Mass. 02154

67

After a summer with Utah International in San Francisco, I am back at Stanford in a law-business program. Just this afternoon I ran into **Mike Kruger** who re-

cently entered the Stanford Business School. Mike has been employed by the navy in Washington. I also encountered a few old friends on the streets of San Francisco over the summer; I spent a good evening with **Fred Goldman** and **Ed Kirsch.** Fred leads the good life on Telegraph Hill and works for Price Waterhouse and Co.; Ed has finished medical school and is looking for a good job.

Isom Herron has received his Ph.D. in mechanics from John Hopkins and has taken a position as a research fellow in applied mathematics at Cal Tech. . . . **Henry Ancona** received an M.S. from M.I.T. in 1968 and then worked for two years at Lincoln Labs. He graduated from Harvard Business School in June and will probably end up working in Paris. . . . Having picked up his M.S. in mechanical engineering from University of Illinois, **Allen Gammon** has probably returned to the real world of employment. . . . Kathy and **Ted Williams** have moved back to the Boston area and are living in exciting Billerica. Ted is an environmental engineer for a consulting firm. . . . **Tom Miller** received an M.A. in mathematics in June from Penn State. . . . **James Cronburg** is working for Town of Winchester Planning Board and designing equipment at a day-care center that Ellen and Turic, 3, go to. Ellen keeps busy teaching and caring there.

Spence Sherman received his Ph.D. in psychology from Stanford; for the past year he has been at the Maryland Psychiatric Research Center, where he has been researching the use of psychedelic compounds in psychotherapy and self-actualization. . . . **Charles Suter** has begun medical school at University of Virginia in Charlottesville. After his release from the navy in 1970, Charles took a few pre-med courses at Stanford. . . . **James Moorer** is a Stanford computer science graduate student. . . . **Paul Goldstein** has started his residency in pediatrics at St. Louis Children's Hospital. . . . In 1970 **Bill Ford** married Shirley Griffin, M.A., University of Illinois. Bill is an Assistant Professor of mathematical sciences at Clemson University. . . . **Wayne Porter** is slaving away in the Pentagon. . . . **Dave Iverson** has moved from New York City to Chicago where he has a sales territory.—**Jim Swanson,** Secretary, 508 Thompson Ave., Mountain View, Calif. 94040

69

At the end of May I tossed all my worldly possessions into an Econoline rent-a-truck and drove to Saint Paul from Harvard Law School to begin a life of lawyering. After taking the Minnesota bar exam in July, I took a short vacation and drove to Lafayette, Ind. for the marriage of **Frank P. Rogers** to the former Betsy Kimball. Among other alumni present at Betsy and Frank's wedding were **Ivan Burns** '69, Kevin McEntee '71, and Bruce Smith '71. On October 20, 1972, I was officially sworn in as a member of the Minnesota Bar.

I have received a considerable amount of mail and will relay some of the information in this issue and the remainder in later installments of the class notes. . . . After attending the Naval Officers Training School at Newport, R.I., **George J. Caporasa** is now stationed in Okinawa and will be out of the navy in December 1972. He plans to return to M.I.T. for his master's and doctorate degrees. His wife, the former Josephine Carusa, a '69 graduate of Northeastern University, is with him in Okinawa. . . . In May, 1972, **Charles Bures** married Janice Gagnon. After a two-week tour of France, they returned to Madison, N.J., where Charles works for Bell Telephone Laboratories. . . . **Peter Zacharias** has completed two years as a commissioned officer (lieutenant) in the U.S. Public Health Service, serving in the Office of the Director, National Institutes of Health, in Bethesda, Maryland. Last summer Pete married the former Kristen Longenecker, Radcliffe '71, and returned to M.I.T. to receive his S.B. and S.M. in mechanical engineering. This fall Pete and Kristen returned to Boston where Pete is now enrolled in the M.B.A. program at Harvard Business School. . . . I received a letter from **Michael Henning**'s wife Harriett who says she wrote when it appeared Mike wasn't going to get around to it. Mike has been designing and drafting for an enamel company in Oakland and is planning in the near future to open his own business of design. Mike and Harriett are proud parents of a three-year-old son who is "as bright as his dad—someday he'll go to M.I.T."

Steven Weinberg has been trying to work out a combined theory of weak interaction plus electromagnetism in the field of particle physics. . . . U.S. Air Force Second Lieutenant **Robert L. Woerner** is now stationed at Westover A.F.B., Ma. Bob is a computer systems operations officer with the Strategic Air Command. . . . **Robert Boyd** is a member of the department of zoology at the University of California-Davis. In an article printed in the August, 1972 issue of *Science,* Bob wrote an analysis and critique of Professor Forrester's *World Dynamics.* . . . U.S. Air Force Second Lieutenant **Michael P. Timko** has been awarded his silver wings following graduation from navigator training at Mather A.F.B., Calif. Mike is now serving at Charleston A.F.B., N.C., with a unit of the Military Airlift Command which provides global airlift for U.S. military forces. . . . I have received a letter from First Lieutenant **Robert McGregor** who is now stationed in Kaisers, Germany. Bob's new assignment has involved a lot of travel by land vehicle or in the air to check out job sites for construction techniques, quality control, safety practices, organization, planning, and supervision. His wife Beth is teaching four nights each week at various education centers in the area. Bob added the following notes on classmates—**Bruce** and Peggy **Parker** have moved to Heidelberg from Karlsruhe. Bruce is back to working with computer programming as it relates to the Army's needs and requirements. . . . **Richard Holthaus** is in London, England, engaged in international banking. He has bought a home in Leeds, south of London, where he and his wife Pam are awaiting their second child. . . . **Robert Listfield** has completed his study at Harvard Business School and is now working for Ford Motor Co. in New Jersey.

That concludes this installment of the Class Notes. More information will be forthcoming in later issues. Please send all correspondence to the new address at the end of this column. Just think. For the first time, the blue dwarf has brought together in this column the continuing story of Mike and Harriett and Bob and Beth.—**Richard J. Moen,** Secretary-Treasurer, 179 N. McKnight Rd., Apt. 318, Saint Paul, Minn. 55119

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The fall season of crisp air, unique aromas, and brilliant foliage has been overcome by winter weather. The class news column has been around for over one year and your class editors appreciate your letters.

Jim Bricker is well into his second year at the Harvard Business School after spending the last summer as a management trainee with Potlach Forests, Inc. in Pomona, Calif. and Fort Wayne, Ind. (my home town). Jim is serving as a student director of the Coop and was a representative to the Student Association at the School. . . . Harvard Medical School claims the body of **Steve Cooper** for a third-year student. Other Tech persons at the school include **Dave Koh, Tim Russell,** and **Chris Rose.** Steve says that his lab partners should get a good laugh at old fumble fingers being a surgeon.

Stanford University is the location for the doctoral studies of **Kenneth Lim** and **Madeline McClure.** Ken is in chemical engineering and bumps into many M.I.T. alumni around the campus. Madeline received her master's in Electrical Engineering and is now studying plasma and solid state physics. . . . **Joan Etzweiler** has gotten a master's degree in nuclear engineering at the University of Wisconsin and is planning on a Ph.D. Joan had a great summer working in the thermonuclear division of Oak Ridge National Laboratory and co-authored two papers on fusion reactors that were given at conferences in November.

Lieutenant **Gregory V. Lewis** has been awarded his silver wings upon graduation from U.S. Air Force pilot training. Gregory received his B.S. and M.S. from M.I.T., and married Cathy Brownell of Schenectady, N.Y. . . . Received an interesting note from **Robert Gerber** revealing that he had gotten a M.S. from Stanford in civil engineering and is presently vice president and part owner of Environmental Planning and Design Assoc., Inc. The firm specializes in land planning in South Portland, Maine. . . . **Alejandro Chou** is working as research and development engineer in the sweepers section of the microwave division of Hewlett-Packard. . . . Got a beam on the class president, **Steven Carhart,** and found out that he is working for the Energy Policy Project in Washington, D.C.

One of the longer letters we received was from Susan and **Lance Tibbetts,** who are both in their third year of medical school. Lance has transferred from Down-

state to Mt. Sinai, so they will be doing their last two years together. They've taken the first part of the National Boards, and passed with flying colors. Now that they've finished their two basic science years, they're embarking on "a new state of our careers. After 18 years in the classroom, we are finally being thrown out to apply what we have learned—SCARY! But I'm sure we will love every minute of rotations on the wards—medical school is great!" . . . Sue and Lance also sent us news of **Eduardo Elejalde.** In February, he married Vanessa Ruiz, a Wellesley graduate who started law school at Georgetown University this fall. Eduardo received a master's in Business Administration last January, and has been working for the World Bank in the Young Professionals program since mid-March.

For those of you who have been wondering whatever happened to our class gift, it's finally getting underway. To refresh your memories, the money was to be used to support socially-oriented research projects undertaken by undergraduates. The fund, which now amounts to nearly $5,000, will be parcelled out over a period of a few years and is being administered by the Undergraduate Research Opportunities Program at M.I.T. Worthy projects will be selected by a board consisting of a faculty member, an undergraduate student, a U.R.O.P. representative, and your Class Secretary.

Robert is completing his first semester at Indiana University school of Law. The academic workload is not so heavy as to preclude many other activities. Anybody in the area is most welcome to stop by, or if that is impractical, write a letter with some good news so that the column can survive.—**Robert Vegeler,** 800 N. Smith Rd., Apt 7W, Bloomington, Ind. 47401; **Laura Malin,** 406 Beacon St., Apt. 1, Boston, Mass. 02215

71

Another academic year and back to the books again. We got married on July 23 and are now living in married student housing at Princeton University. Being out of the Boston area, where there is a high concentration of '71ers, we're going to have to depend totally on your letters in order to write this column, so *please* send us mail.

Hal Moorman wrote us a nice long letter to bring us up to date on the Class of '71 Delts. "**Mike Oakes** and his wife Vicki (Emmanuel) have returned to Houston. Mike will work as chief engineer for Oakes Construction Company. He's enjoying working and living in Texas. (Ed. note: Hal's a Texan.) . . . **Buddy Knarr** is working for Lulejian and Associates in California. That's about all I know; if you have his address I would appreciate it. (Ed. note: if anybody knows his address, please send it to us so we can forward it to Hal.) . . . **Chris Brewster** is working in Atlanta for C and S Bank, enjoying money and three piece suits and southern living. . . . **Jim Shields,** after graduating with his master's, will work for a firm outside of Boston. . . . **Cliff Ananian** has accepted a job with a firm in Spartanburg, S.C. He also plans to marry Cindy Allen (B.U.) this summer (1972) . . . I'm (Hal Moorman) working in a civil engineering consulting firm in Houston, and also selling real estate in Brenham, Texas, but plan to return to grad school in the next two years."

Dick Park wrote to say, "I have spent a busy first year at the University of Pennsylvania Law School. I am entering the University of Maryland Hospital in Baltimore on June 4 (1972) to have a slipped disc removed." . . . **Linda Getch** dropped us a note to tell us "I am currently in a master's program at NASA—Langley Research Center for George Washington University. The master's program lasts for one more year leading to a master's in Flight Sciences." . . . **Don Black** read our reference to him in the May, 1972 column and was so thrilled that he wrote to us saying, "You sure do need a disclaimer. Here's mine: There is *no way* that I am 'a private in the army.' It was to make sure of it that I joined the Pennsylvania National Guard last September."

The exuberant notice you got from Ft. Leonard Wood was because of the fact that even guardsmen have to go through basic. I received additional training at Ft. Carson, Colorado, in general drafting (no pun), and returned home for good in mid-March. That's where I am now, looking for work, reading, and otherwise psyching up for U. of Pennsylvania Law School, which starts at the end of this coming August (1972) for me."

Jack Hiatt wrote, "Presently at Stanford Business School. California is far out. Will be in Boston at State Street Bank this summer (1972). Has anyone heard from Glowienka?" . . . It just so happens that **James P. Glowienka** wrote in to say, "Married Linda P. Bock, June 19, 1971, a graduate of SUNY, New Paltz; am currently attending University of Chicago graduate school of business. Working toward an M.B.A. Am finding Chicago a hostile city—too much crime too close. Can't wait to get back to New England with its friendly people and big hills to ski on." (Ed. note: Glowienka didn't ask if we heard from Hiatt!).

Mrs. **Raisa Berlin Deber** has happy to note that we wrote about her in the May issue. She replied, "Close but no cigar! Yes, I'm still at M.I.T.—Political Science department—but not still struggling for my S.B. I got a joint Bachelors-Masters June '71—am now engaged in pursuit of a Ph.D. to clinch my unemployability. Also, I was married in Jan. 1971 to the legendary Charles M. "Chuck" Deber, Ph.D. 1967."

Jerry Bushnell is working as a design engineer for John Fluke, Inc. in Seattle. . . . **John A. Stefano** married Karen Rhea Goodman, and is now attending the State University of New York at Buffalo, School of Medicine. . . . A note from **Bill Swedish** reads "Finally got my master's through the Flight Transportation Lab, and started working almost immediately for Landrum and Brown, Inc., here in Cincinnati. They're airport consultants, so it's right up my alley. Cincinnati is pretty nice, easy to feel at home here, although it's definitely not like Boston." . . . And finally (for this time), **Gary B. Leon** is studying for his doctorate in math at the University of California at Berkeley, "having escaped the endless Massachusetts winter."

We really do hope to hear from you.—**Howard Jay Siegel,** President, and **Leah Jamieson Siegel,** Executive Committee Member, 228 C Harrison Street (respectfully), Princeton, N.J. 08540

72

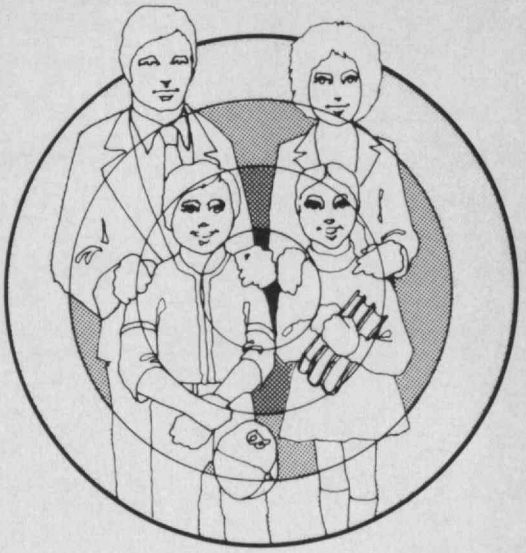
I am still amazed at the number of you classmates that I run into whenever I am at the Institute. I find that **Mark Laventhal** and **Bill Mark** are doing graduate work in computer science. **Don Falkenstein** in E.E., and **Mario Guerrero** in Mechanical Engineering. . . . Also **John Scalea** and **Robert F. Walter** in Aeronautical Engineering. Bob's interest is nuclear rocket propulsion. . . . **Don Marsh** is spending this year picking up a double degree in math and physics. . . . **Ken Kempson** is programming for the Office of Administrative Systems and will shortly be going into the navy. . . . **Dan Bloom** is assistant manager of East Campus and Senior House.

Others still in the academic world include **John Yee** at Queen's College In Ontario, and **Jason Bitsly** at Princeton, both in math. . . . **Robert Ellis** writes that he is at Ohio State Law School. . . . We have a number of classmates who have simply moved upriver. **Bob Schulte** and **Ken Weisshaar** are living together in the Harvard SAE house and attending the business school, as is **Bill Perry.** Also **Conan Li** is in biophysics and **Gerald Zuckier** is in psychology at Harvard Grad School. . . . **Dan Witschey** writes that he and **Barbara Swartz** were married on August 6. He is a student at the University of Texas Law School.

Janet (Saul) Lantner writes that she is a management engineer with the G.E. aircraft engines group. She and **Gary** have been travelling to the South Pacific and have visited Hawaii, Australia, and the Fiji Islands. . . . **Chip Kimball** and **Craig Lewis** spent the summer amid numerous adventures on a cross-country bicycle trip, all of which was recounted in the *Globe* magazine section in September. . . . **Harlan Ives** reports "I am now at Yale Medical School. This summer my wife and I loaded our packbags into the station wagon and headed for California. It was quite a trip, the highlight being an evening at the world-famous Rye Patch Reservoir in Nevada. We were accompanied by Alex Jacobson."

Maury Goodman has graduated and is campaigning in Virginia for McGovern. Finally your secretary was pleased and surprised, but mostly surprised, to find that he really graduated in September and began to look for a job in the real world.—**Dick Fletcher,** Secretary, 135 West St., Braintree, Mass. 02184

How higher interest can help pay for your kids' higher education.



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It Takes A Very Big Thing To Make A Very Small Thing

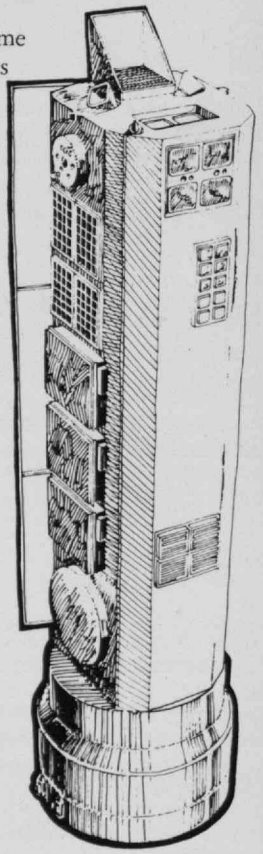
When they're not actually living together in tight quarters, those positively charged particles called protons can't stand one another's presence. If you try to bring two of them together, they fly apart at a great rate. Yet the carbon in your body has six protons sharing the small apartment of its nucleus, and the oxygen you are breathing has eight. Eighty protons are crammed together in the nucleus of a heavy element like Mercury, while the nuclei of the heaviest elements entertain lavish parties of more than 100. How were these mutually repelling protons assembled in the small compass of a nucleus? What force in nature is strong enough to have squeezed such inimical particles into such a tiny space?

The answer seems to lie in the stars. Stars are huge chemical factories within which matter is made. The great temperatures and pressures found inside stars drive together the nuclei of light elements like hydrogen (which contains a single proton) to form the heavier elements. The process is called *nucleosynthesis*. Our own star, the Sun, for example, fuses four hydrogen protons together and makes helium. At a later stage in its life, it will begin building other elements from the helium like carbon, then oxygen and neon. Eventually, it will make magnesium, silicon, and, finally, iron.

Many stars stop there and end their lives as "white dwarfs." In some, however, the process continues to even heavier elements. A few make all of the elements. These erupt in gigantic explosions called supernovae and hurl out the matter they have made in great clouds or nebulae. Some scientists believe that this matter eventually gathers together to form planets. All of the matter that makes up the Earth and its inhabitants, for example, may well be stardust. (Incidentally, Sir Arthur Eddington, not Hoagy Carmichael, is responsible for this insight.)

As the stars drive the nuclei of the elements together in thermonuclear reactions, a small fraction of their mass is converted to energy. Part of this energy comes forth as visible light, making the stars shine. Other parts of it stream forth as invisible radiation—X-rays, gamma rays, radio waves, heat, and so on. These energy by-products are valuable information, for they indicate what the stars are making, how old they are, how far away they are, and a number of other things.

Beginning in 1975, NASA's High Energy Astronomical Observatory (HEAO) will collect data on the high energy electromagnetic output of stars and the nuclei and electrons they sometimes eject (known to us as cosmic rays). It will give us fundamental information on some very important questions such as how matter is made, how old and how big the universe is, and where our planet may have come from.



To intercept these relatively rare high energy particles and short wave lengths, you need large, heavy detectors. Thus HEAO is big. In fact, it's three stories high and weighs around 10 tons. TRW is building it for the Marshall Space Flight Center.

We're very happy to be associated with this program. Because stars are a primal source of matter and energy (and hence you and me), we think HEAO is one of the most scientifically fascinating programs to come along in a long time. After HEAO goes up, we'll keep you posted on what the stars tell us.

For further information, write on your company letterhead to:

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